GENERAL
TECHNICAL
DATA

Vintage Radio Identification SKETCH-BOOKS of D. H. MOORE

VOLUME VII

The Editorial Group, Ltd...

P.O. BOX 521 • PALO ALTO, CALIFORNIA

PUBLISHING HISTORY

First Edition: © D.H.MOORE, 1954.
2nd Printing: © D.G.YULE, 1985

Second Edition: © D.G.YULE, 1986.

Third Edition: © RAY FOSTER, 1987
2nd Printing: © RAY FOSTER, 1987

All rights reserved. No part of this book text or illustrations - may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, or recording, without the written permission of the copyright owner. For information, write to the publishers.

Library of Congress Catalogue Card: 87-98347

DEDICATION

.....to a way of life
that should not have
been forgotten.

Acknowledgements

Bits and pieces of these volumes have been published, referenced, reviewed in several media devoted to the hobby of vintage Radio, including a few foreign countries, such as New Zealand, Japan, Canada and England. Such favourable notice for such a labour of love is hereby acknowledged in appreciation.

Thanks must also be offered Stan Lopes who tediously editted the technical authenticity of circuitry to be found in Volumes II through VII. His labours have resulted in an obvious authenticity, we feel, especially for those who delight in tracing out vintage schematics. He even found technical errors in original sources!

Special thanks are due Douglas G. Yule, who originally sponsored this effort as a contribution to the hobby, without whose prompting these Sketch-Books may not have come into existence. Also, thanks are given to Howard W. Granoff, of the OLDE TYME RADIO COMPANY, whose unflagging enthusiasm and publicity has done much to make these Sketch-Books known within the fraternity.

And in as much as fraternalism is the basis for shared enthusiasm, which is what any hobby is, and because of the original and dramatic shift away from the current vintage Radio fare, it follows that the publishers and the author, being human, would appreciate hearing from you, your comments, along with any suggestions you'd care to offer with an eye to producing bigger and better vintage Radio literature in future.

Vol.VII: General Technical Data

INTRPDUCTION..... 1

ACME D-Coil..... 9
ACME RF Xfrmr. Detail..... 97
Adding A Power Tube to TRFs.... 101
Aerial Boosters..... 46
AF Jack Connexions..... 90
AF Xfrmr. to Impedance..... 75
AF Xfrmr. Internal Connexions.. 75
AMPERITE Designations..... 65
Anti-Motor Boating..... 103

"Baby" 1-Tube Detectors..... 57
Base Diagrams, Vintage Tubes... 92
BOONTON Reflex..... 69
B-Eliminator & Trickle Charger. 99
Battery Drain 01A, 12A, 71A.... 83

Carborundum Xtal. Receiver..... 62
Capacity-Reactance-Henries..... 67
Causes of Oscillation..... 82
Charger For 90V Battery..... 102
Chassis Configurations..... 100
CE-CO Lettered Tubes..... 63
Coil Computation..... 68
Coil Winding Forms..... 61
Commercial Tuner Connexions.... 57
Coupling Capacitors..... 86
Crystal Detector Data..... 47

"D"-Coils of 1925..... 7

Early Schematic Symbols..... 92
Electro-Dynamic Speaker Note... 78
ELKAY Designations..... 63

Ghirardi's Coupler Hook-Up..... 54

Hard vs. Soft Tubes..... 85
Home-Made Wave-Trap..... 84
Hum Elimination..... 84

Inductances: Honeycomb Coils... 66
Improving By-Pass..... 74
Improving Coupling Device..... 74

Improving TRF Sensitivity..... 101

Jones Multi-Plug Details..... 80

Madison-Moore Osc. Note..... 73
Matching Impedance..... 89

Odd Tube Designations..... 64
Open Winding Repairs..... 77
Oxide-FIL Tube Rejuvenation..... 64
OlAs As Rectifiers..... 102

Proper Voltage Measurements..... 87
Push-Pull Substitute..... 76

Radio Widow, A..... 11
RCA Catacombs..... 42
Reclaiming Sulphated Batteries.. 68
Relative Resistivity of Metals.. 67
Rheostats For FIL Control..... 63
Rheostat/Potentiometer I.D..... 80
Regenerative Tube & A-K Hook-Up. 81
Resistance-Coupled Amplifiers... 13
Resistance Coupling to Cones.... 78

Samson RFC Numbers..... 64
Sangamo AF Xfrmr. I.D..... 76
S-M Coil Data..... 58
Sole Source Data..... 63
Standard Colour Code, Resistors. 12
Soldering Old Buss-Bar..... 71

Three-Point Loop Connexions..... 98
Transformer to Impedance..... 79
Toroidal Coils..... 3
Typical Impedance Configuration. 76

Value of C-Bias..... 88
Variometer vs. Vario-Coupler.... 2
Vintage Tube Substitutions..... 70

W.E. 518W Speaker Note..... 69

* * *
* *
*

INTRODUCTION

While bits and pieces of technical information can be found scattered throughout the pages of conventional references, there is no single source available for organised data. This volume of the Sketch-Books attempts to offer such a single source reference for that kind of incidental information that is frequently helpful in restoring, checking-out, aligning, constructing, vintage radios.

The following pages are NOT offered as a totally comprehensive survey of such information, as that would require several volumes, but what data as are presented here are valid and useful, and, in a few instances, unavailable anywhere else.

The constructional sketches are complete enough for you to construct original items from original specifications offered the early set-builders - and constructing your own has an appeal all its own, you will find. There is a definite sense of accomplishment that you cannot get from putting together a Heathkit, for example.

Statistical data in media are usually passed over, but when you need such, it's satisfying to know you have a single source, rather than having to wade through many media looking for a chance reference.

In the following pages you will find detailed informational data about the following early radio adjuncts, among others:

Coil Winding Forms	Crystal Detectors
Toroidal Coils	Commercial Coil Data
Early Schematic Symbols	Wave-Traps
Recharger Circuitry	Iron-Core Xfrmr. Construction
B-Eliminators	Antennae Gimmicks
Technical Tips	RF Boosters
RCA Catacombs	Resistance-Coupled AF Amplifiers

While it was almost a fiendish vogue among writers for our early Radio magazines to compile endless charts, graphs, nomographs, or logging charts, they actually served very little purpose, other than to perhaps massage the ego of the writer. For the layman, intricate charts and graphs look mysterious, like the cassock of the clergy or the shelf after shelf of uniformly bound books in a lawyer's office. Few are here.

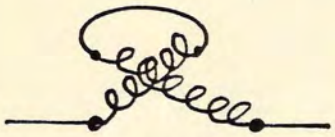
Scrounging for original parts, or equal substitutes, in order to construct one of the early circuits, is where the fun of vintage Radio really lies. That is the lure, and the satisfaction.

* * *

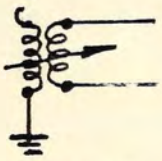
VARIOMETER vs. VARIO-COUPLER

A VARIOMETER is a variable inductance coil used to give a continuous variation of inductance in a circuit. It is used for the sole purpose of tuning to short-waves. Variometers consist of pairs of coils (two to an instrument, although Samson and Pioneer, among others, used dual rotor variometers) always connected in series so that one coil can rotate inside the other. Rotating the inner coil successively opposes or adds to the inductance of the outer coil.

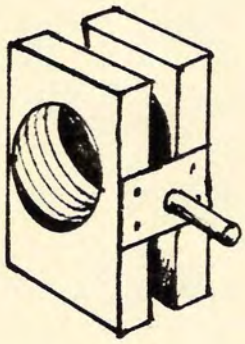
A VARIO-COUPLER consists of two coils, one rotating within the other - without physical connexions - other than the inductance between them. It is used to transfer energy from one circuit to another. It is satisfactory only on short-waves. The PRI is tapt so as to give the proper inductance for different wavelengths, corresponding to the variation secured by using different sized coils. Below are identifying sketches, and early electrical symbols.



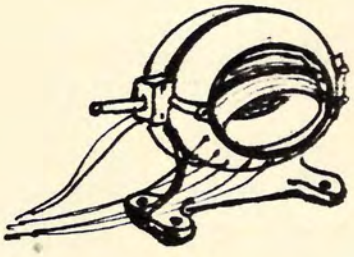
VARIOMETER



VARIO-COUPLER

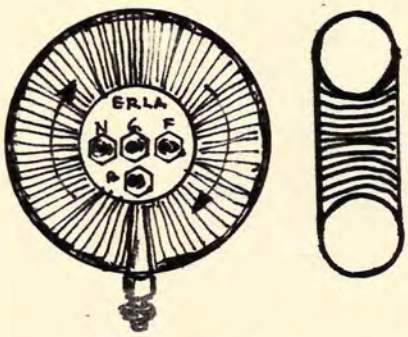


WORKRITE - 1922
Original Cost $5

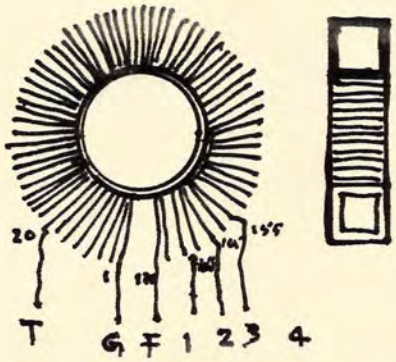


PIONEER - 1923
Original Cost $7.50

THE TOROIDAL COIL



ERLA "BALLOON CIRCLOIDS", 1925



HARRY A. BREMER's "TORODIAL" TOROIDAL COIL, 1926 (B-T)

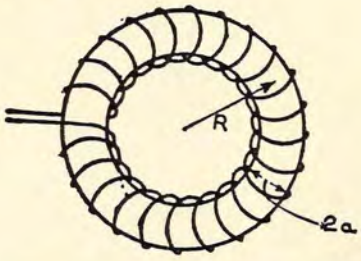
Like many other aspects of early radio, the designing of inductance coils varied with the extent of the imagination of engineers, and their electrical ignorance. As was the fashion, then and now, a single aspect of any design was always highly touted in media as the ultimate cure-all for all problems.

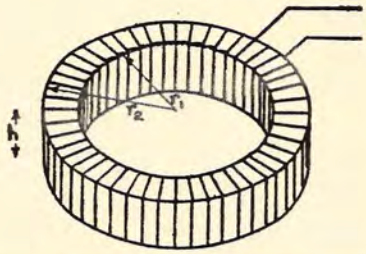
There were at least 10 popular toroidal coil manufacturers at one point, some being effective, some produced by opportunists. Their popularity lasted about two years, from about 1927 through 1929, in circuits by Bremer-Tully, Erla, Madison-Moore, Cardwell, All-American.

The chief claim of the toroidal coil designers was that it had practically no external field. However, what was not mentioned in the adverts of the time, was that the resistance of this coil for a given inductance was extremely high.

It was eventually realised that for a given amount of inductance the most efficient type of inductance coil was the simple solenoid having a ratio of diameter to length of about 2:5. This ratio could be reduced to 1 or even 0.75:1 without making an appreciable difference in efficiency.

The point of toroidal-circuloid-"doughnut"-toro-tran-torostyle-torodial coils was to confine the magnetic field within the coil, to eliminate radiation, inductive coupling between stages, and freedom from external interference. The simplest form was a ring with a rectangular cross-sexion, exemplified best, perhaps, by Bremer-Tully. The round cross-sexion was favoured by such firms as Erla and Rauland.



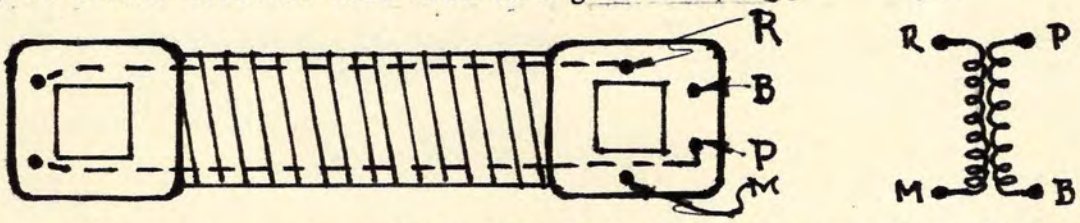


Inductance for the rectangular cross-sexion was figured as follows:

$$L = .0117\ n^2 h \log^{-10} \frac{O.D.}{I.D.}$$

where: L = inductance in mH
n = total number of turns
h = height/thickness of coil
O.D. = outside diameter
I.D. = inside diameter

There was a maximum number of turns possible with a given wire size wound in a single layer, on a given I.D. For calculation nomographs for torodial coils of the period, see Popular Radio, March, 1926, pp. 255-257. The Harry A. Bremer toroidal coil will be a good example.



170 turns Tapt @ 10, 140, 155, 165, 168 turns from Grid end
#24 D.S.C. PRI was the inside coil: SEC was the outside

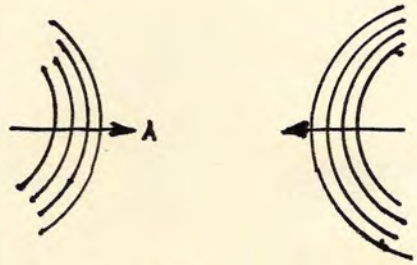
Cross-Sexion = 1.5" for square form; 1.75" for round form

The PRI was wound on internal celluloid form to fit 120^0 inside the FIL end of the SEC winding. The PRI winding was 25 turns of #36 enamelled wire. The sketch above shows typical internal connexions; designations on the preceding page are as follows:

F = FIL end of SEC G = Grid 1,2,3,4 = taps

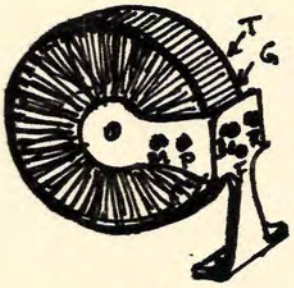
These designations were typical of all T-A coils; all T-C coils were tapt at T only on the sketch. The COUNTERPHASE winding was space-wound on the PRI, between PRI turns, and consisted of 25 turns, #36 enamelled wire.

Epitomised Theory



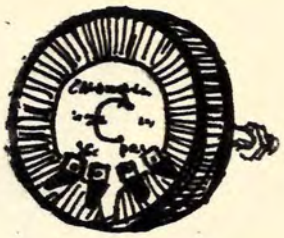
"A" = stray field moving towards coil. Induced currents oppose each other = no current flow = no pick-up.

Wave-front at right angle to coil. Opposing currents are set-up in opposite sides of the coil, preventing interference.



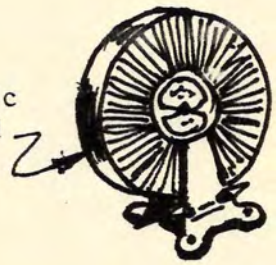
B-T, 1925
"Torodial"

B-T, 1924
"Torostyle"



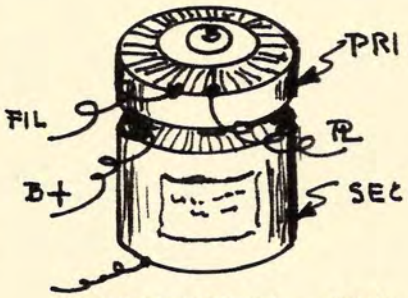
CARDWELL, 1925
"Toro-Tran"

Plastic Shield



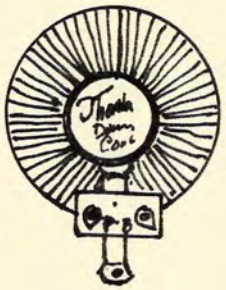
ALL-AMERICAN, 1926 - in the advert copy for this coil were the following words: "Comparative freedom from the influence of other apparatus and atmospheric interference; will not send its own field roaming around the receiver."

R. M..E.
('23-3.50)

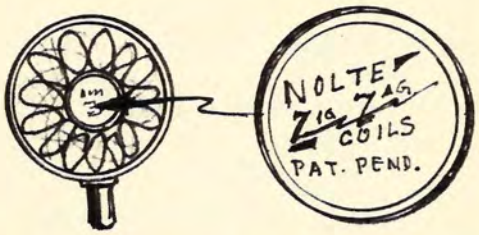


"DOUBLETOROID" - 1925
(Radio Foundation)

SUMMIT TORODIAL
('25 - 10)

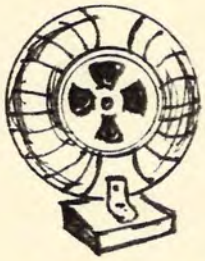


THOROLA
(Reichmann)
('23-2)



NOLTE "Zig-Zag"
('25 - 7.50)

"THOROLA"



NAXON - '26

In terms of true efficiency, it was early on demonstrated by engineers that a laboratory comparison of all types of inductance coils - honeycomb, spider-web, bank-wound, paddle-wheel, solenoids and toroids - demonstrated that the conventional single-layer solenoid coil was the most efficient. Today, of course, we have only solenoid coils.

In passing, it might be of interest to mention that among all early coils, as being the least efficient, were those made by COTA; the most efficient having been those solenoids made with #18 bell-wire, D.C.C., on a 3" diameter composition coil-form, usually Formica or Bakelite.

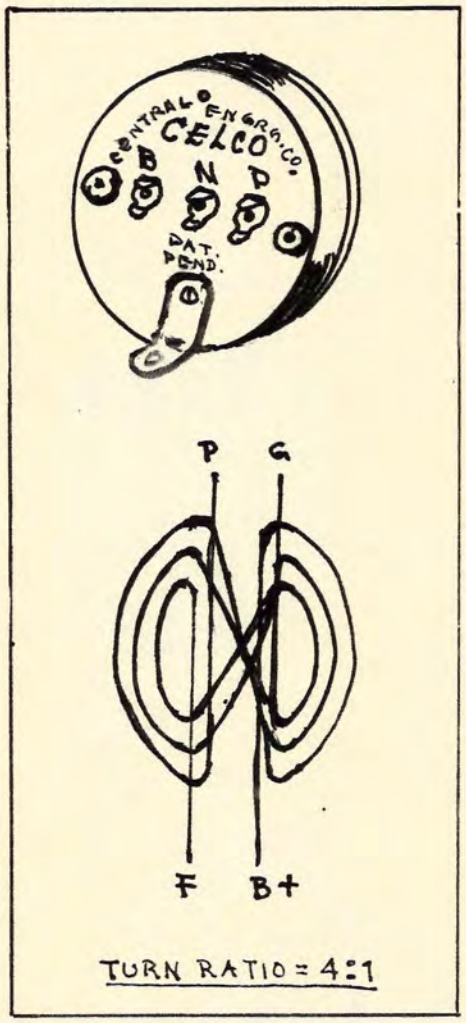
The toroid coils were found be fall in the middle of such efficiency tests, with those coils made by ORBIT and ALL-AMERICAN giving the best results. Distributed capacity was also a bug-bear, and in testing for such among the coils listed above, it was found that again ORBIT and ALL-AMERICAN and ERLA were best among the toroids, with PATHÉ and FRESHMAN solenoids being at the top of the list as best all-around inductance coils.

It seems, then, that the greatest inductance was obtained for a given amount of wire when the coil form had a true cylindrical shape. Another reason was the skin-effect, as the skin-effect in multi-layer coils was much greater than in any single-layer coil.

Parenthetically, because it caused me to smile when I found out about it amid my research, the S.S.Kresge stores were, for awhile, sole distributors of the LORENZ coils - a Cota/Remler type. Kresge was, of course, one of the shops in direct competition with Woolworths: and in the early Twenties one could buy radio parts in all such shops, and for nickels and dimes. Such stores also stocked spare-parts for the Model "T" Ford, you may remember - if you are of my generation.

* * *

THE "D" COILS OF 1925



Celco, Sickles, Victoreen, Madison-Moore, among others, utilized this configuration, or a modification thereof for their various encased coils.

The "D"-coil got its name from the fact that both PRI and SEC windings went back and forth in a "D" and a reversed "D" configuration. The first extensive publicity given the "D"-coil appeared in Radio Journal, 1924/-25. The original Celco coil, manufactured by the Central Engineering Compant, is shown at the left. It was wound with very heavy wire, said to reduce resistance internally.

Advantages claimed were that it created a closed field running around and passing through the openings of the two "D" forms. This closed field precluded interference between stages, thus permitting mounting the coils and other components much closer together on a baseboard.

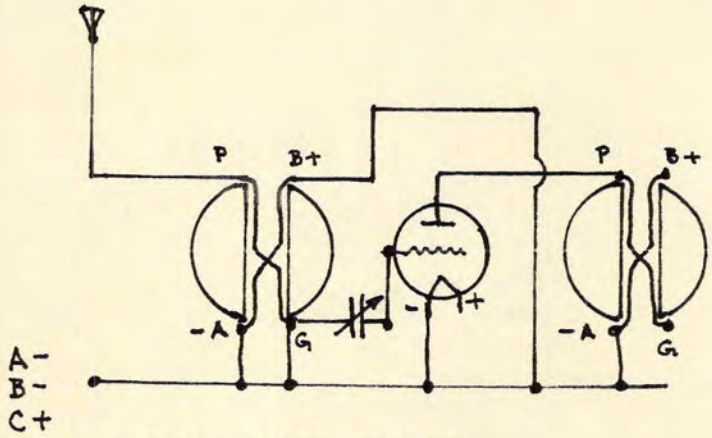
CELCO coils were peaked at 32 KC. This was done by a condenser across the SEC winding, placed inside the casing. Those commercial coils having a terminal marked "N" permitted attaching a neutralizing condenser, if desired. Attaching a neutralizing condenser would sometimes give better control of plate-grid capacity feed-back.

Harry J. Marx, probably the most outstanding draftsman of early radio schematics and diagrams, and who always insisted that his name remain on his reproduced drawings in the media, did design a 7-tube super-het using Celco coils, and which is detailed in Volume II-A of these Sketch-Books. Central Engineering continued to produce their coils for a few years, but were superceded by better coils, such as the Victoreen, Madison-Moore, Remler, and Magnaformer.

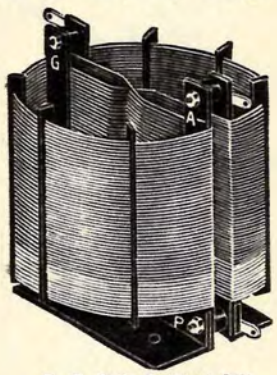
Aside from CELCO, there was another D-coil that enjoyed much popularity during 1928 - the ELLIS-D, which sold for $2.50, in two versions - that is, RF and oscillator coupler. Ditto ACME.

It differed from CELCO in that it utilized a different method of reducing distributed capacity - by means of what their engineers called group-space-winding. Instead of the usual method for winding of the times, it was found that it was more efficient - i.e., produced a more efficient coil - to wind 4 turns closely together, leave 2 spaces of turns, wind 4 more turns, skip two runs, etc. This applied to both the Primary and Secondary windings.

Theoretically, the effect of this method was: 1) a reduction in distributed capacity to minimum; 2) a reduction in RF; 3) complete freedom from interference and external pick-up.



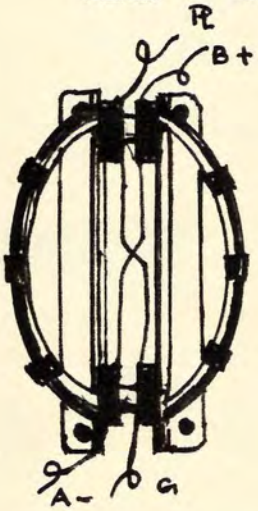
TYPICAL D-COIL HOOK-UP



R. F. Coils Matched Sets. Per Coil, $2.50

ELLIS "D" Coils

HENNENGER, 1926



PLAN VIEW OF THE ELLIS D-COIL

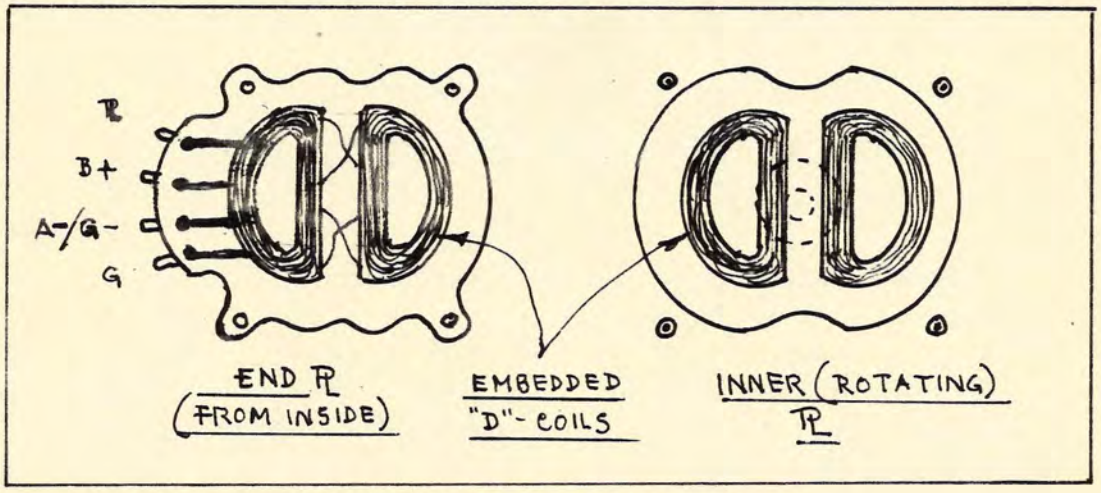
ACME D-COIL

The ACME D-Coil of 1925 (detailed over-leaf) was, with no contest, the most elabourately designed D-coil of any. It consisted of a 500 MMF variable condenser, housed in a pot-metal frame, enclosed with an Eisenglas cover, and terminating in two large black Bakelite end-plates - one of which was controlled by the variable.

The two end-plates had two D-coils embedded in each, with the fixed coils having the conventional 4-point lugs. A spring-loaded vernier drive was also inside the Eisenglas enclosure, and was operated by friction, pushed in to press against a pot-metal drive disc. In operation, the rotating D-coils altered their inductance with the fixed D-coils, through 180°. The variable plates were brass.

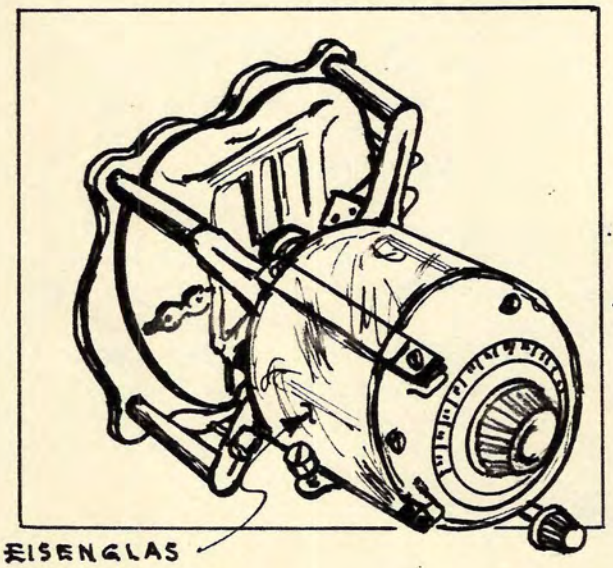
The ACME D-Coil was always used in conjunction with a conventional 500 MMF variable, also enclosed in Eisenglas and with a similar friction-drive vernier adjustment.

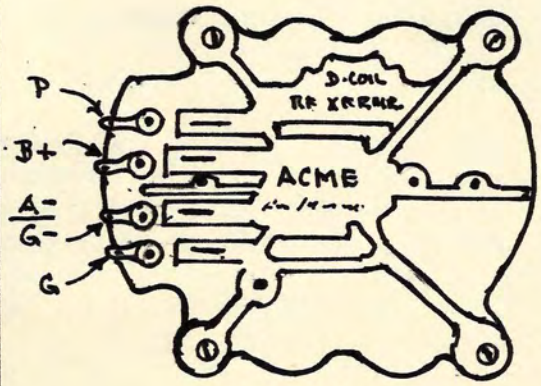
A most over-sophisticated design concept, the ACME D-Coil assembly, which is what it actually was, proved too sophisticated for the legions of home-constructors of the time, and was dropt by ACME from production in less than a year.



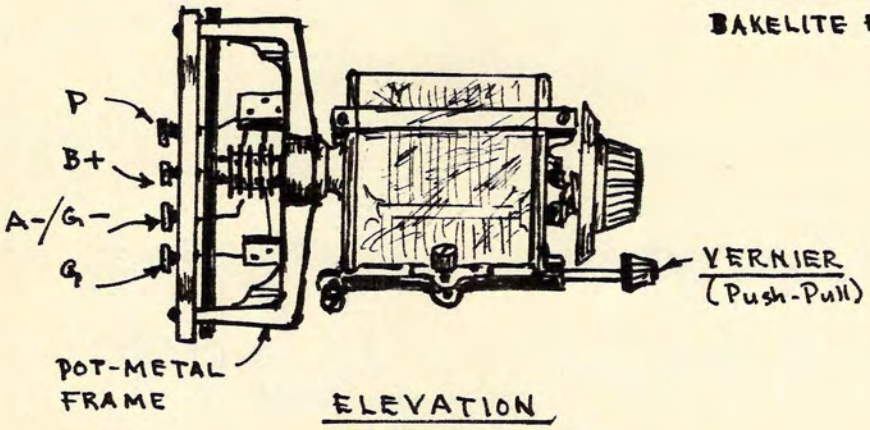
ACME D-COIL (RF XFRMR.) DETAIL

ACME "D" COIL: Sht. 2





REAR VIEW
(5"x6 3/8" O.A.)
BAKELITE END PLS



ELEVATION
(7 1/2" LG. O.A.)

SECURED TO FRONT PANEL VIA THREE THREADED BOSSES; BOSSES UNDER DIAL. DESPITE ITS UNORTHODOX DESIGN, IT IS CONNECTED INTO A CIRCUIT LIKE ANY OTHER RF COIL. G- & G MAY BE CONSIDERED AS A- & A+, WHERE APPLICABLE.

A RADIO WIDOW

By RUTH DEAMER

My husband has a radio set,
He's had it just a year,
But if it stays another week—
I'm going away from here.

I'm tired of taking second place,
And don't see why I should;
I'm going back to Mother's,
For I know she'll treat me good.

We used to have just lots of fun
Before he got this pest,
And now that he's an amateur
He's nutty like the rest.

A "ham" drops in most every night,
Perhaps 6XYZ,
Or some such silly person—
Who has no use for me.

They turn the knobs, and twist the dials,
Change the wires too,
And wonder why—with single tubes
They can't hear Kalamazoo.

Some one comes on with music,
But as they start to play
We skip from "Red Hot Mamma"
To "The End of a Perfect Day."

A sermon or a recipe,
It doesn't matter which,
They're cut in two completely
When the boys decide to switch.

They talk about grid-leaks,
The rheostats, and such,
And if I change the subject
I'm sure "to get in Dutch."

Thus we spend our evenings—
Or nearly every one,
So I can't see just where and how
I'm having any fun.

Since we don't go to dances
I'm getting stiff—and say!
If this keeps up I know for sure
I'll soon be turning gray.

And so this world and then the next,
But I hope where 'er I go
The place won't be all cluttered up
With some old radio.

(1923)

Standard Color Code for Resistors

Megohms	*Ohms*	*Body*	*Dot*	*End*	*Megohms*	*Ohms*	*Body*	*Dot*	*End*
.005	500	Green	Brown	Black	.075	75,000	Violet	Orange	Green
.00075	750	Violet	Brown	Green	.09	90,000	White	Orange	Black
.001	1,000	Brown	Red	Black	.1	100,000	Brown	Yellow	Black
.002	2,000	Red	Red	Black	.15	150,000	Brown	Yellow	Green
.003	3,000	Orange	Red	Black	.2	200,000	Red	Yellow	Black
.004	4,000	Yellow	Red	Black	.25	250,000	Red	Yellow	Green
.005	5,000	Green	Red	Black	.3	300,000	Orange	Yellow	Black
.006	6,000	Blue	Red	Black	.5	500,000	Green	Yellow	Black
.007	7,000	Violet	Red	Black	.75	750,000	Violet	Yellow	Green
.008	8,000	Gray	Red	Black	1.	1,000,000	Brown	Green	Black
.009	9,000	White	Red	Black	1.5	1,500,000	Brown	Green	Green
.01	10,000	Brown	Orange	Black	2.	2,000,000	Red	Green	Black
0.12	12,000	Brown	Orange	Red	2.5	2,500,000	Red	Green	Green
0.15	15,000	Brown	Orange	Green	3.	3,000,000	Orange	Green	Black
0.2	20,000	Red	Orange	Black	4.	4,000,000	Yellow	Green	Black
.025	25,000	Red	Orange	Green	5.	5,000,000	Green	Green	Black
.03	30,000	Orange	Orange	Black	6.	6,000,000	Blue	Green	Black
.04	40,000	Yellow	Orange	Black	7.	7,000,000	Violet	Green	Black
.05	50,000	Green	Orange	Black	8.	8,000,000	Gray	Green	Black
.06	60,000	Blue	Orange	Black	9.	9,000,000	White	Green	Black
					10.	10.0000.000	Brown	Blue	Black

The standard adopted for resistors, whereby they are color coded, comprises ten colors, with numbers from 0 to 9 for each different color. The location of the color gives the digit sequence. The body color represents the first figure, one end is colored for the second figure, while a stripe or dot designates the number of ciphers to follow. The above table gives the colors, with two expressions for the resistance, megohms and ohms.

We have all encountered early radio sets whose circuits contained a plethora of early colour-coded carbon resistors. Oddly enough,I found that such coding of resistors was used even into the early years of Hitler's War. The above data are not readily available - in such completeness - and because modern ohm-meters will give an assortment of rather odd values with the early resistors, the above data should prove helpful to you. Needless to say, tolerance was much broader for resistors in the early days, so simply round off the value you get to the nearest modern carbon or film types.

RESISTANCE-COUPLED AMPLIFIERS

A Preliminary Treatise

In the beginning there was an obsession for reception, any kind of reception, intelligable or not. As the art advanced there was a pre-occupation with "tone", and from flimsy PM speakers evolved the massive and frequently ornate dynamic and electro-dynamic spakers. It was inevitable, of course, that another synthetic controversy arose.

It was actually the longest-running editorial controversy, the debate over the virtues and demerits of the four types of AF amplification - *i.e.*, transformer-coupled, impedance-coupled, push-pull, and resistance-coupled. The controversy ranged from Zeh Bouck and the very articulate Henney, to Lynch and Priesley. Nothing was advanced, of course, and the controversy died a natural death under the avalanche of rapid new discoveries or applications. But such controversies, sophomoric as most of them were, did have one positive effect upon an army of Radio media readers - they were confronted with the necessity for thinking, of crystallising their own thoughts.

I have constructed and experimented with about 50 or so of all types of the early AF circuits, and found that Henney was correct when he editorialised that the impedance-type was the most inferior & Harris was correct when he wrote that the transformer-coupled type is the easiest, and the cheapest to produce, and that manufacturers were going to push that type - which they have done ever since.

While some of the advert claims by such firms as Thor and Daven and Na-Ald were obviously puffered, it is easily demonstrable I find that the resistance-coupled AF amplifiers can produce the purest tones, and with the proper power tubes and hi-mu tubes, will produce volume enough to fill a hall. Such circuits were clean in design, are practically fool-proof, and will work with any circuit.

The following free-hand sketches offer a handful of better

R-C circuits. The parts and components required can usually be found in your "junk box". So, on some odd Thursday when it's raining, have a go at constructing one or two.

* * *

Simply stated, R-C AF amplification is an early system which allows intensifying current variations through the magnifying action of the various tubes of the day. The signal from one tube is passed along to the next tube through the functioning of a high resistance included in the plate circuit of the preceding tube.

With any incoming signal, the plate current of a first tube necessarily varies in amplitude, which causes changes across the potential existing at the terminals of the following resistor. This varying potential is applied to the grid of the next tube through the mandatory coupling condenser (called an "isolating" condenser in the early days). This condenser isolates the high positive potential applied to a first tube. The fourth resistor is a conventional grid-leak, preventing choking by an accumulation of excessive changes in the grid.

One of the virtues of an R-C amplifier is that once you have decided on the circuit you prefer, the values of the components remain constant. This is not true of other types, especially push-pull.

The ordinary transformer-coupled and impedance-coupled types may be considered allied, in that the latter has two windings in which the coefficient of the coupling and the turns-ratio are near unity. The later models of Alden's "Truphonic" amplifier is a good example. Impedance-types act as an auto-former, the same windings acting as PRI. and a part of the SEC, at the same time.

In the transformer-coupled type, the maximum amplification a stage at a time is equal to the amplification constant of the preceding tube, multiplied by the turns-ratio of the transformer. The voltage of the SEC bears the same ratio to the input, or PRI, voltage as the number of turns in the SEC bears to the turns of the PRI. In other words:

$$\frac{v1}{v2} = \frac{n1}{n2}$$

where:

v1 & v2 = PRI & SEC voltage.
n1 & n2 = PRI & SEC Turns

This step-up voltage occurs only under certain theoretical conditions, which are never attained in actual practice. However, the maximum voltage attainable in a transformer-coupled type is:

$$K = \mu \frac{n2}{n1}$$

where: K = total voltage amplification
μ = Voltage amplifying constant of tube.

All early transformers were noted for their distortion, as they could not produce the same amplification at all frequencies. The result of this was the development of the three other types of audio amplifying systems. The R-C type remained the most popular, not only with set-constructors but several commercial manufacurers as well.

The relationship between input and output of the R-C types is practically linear. What distortion may occur is due to stress imposed by unfavourable tube characteristics. While the amplification a stage at a time is not so great as that of the transformer-type, the results per dollar spent was and is the ultimate standard in terms of efficiency, and here the R-C types rank foremost.

The early push-pull amplifiers actually increased output a very small amount when compared with the transformer-coupled circuits but the P-P type was capable of killing distortion, using a considerably higher plate voltage without over-loading the tubes. The C-bias, sometimes of a very high order, was mandatory.

* * *

Three stages of R-C amplification are quite sufficient for most purposes, giving amplification generally greater than a 2-stage transformer-coupled type. Two stages inputted from an *efficient* tuner of the reflex type will drive a speaker easily. More than a 3-stage R-C amplifier is not recommended with reflex and super-het sets. Four stages have proved to be the practical limit, and a switching device for putting out the fourth tube should always be provided, as it's not needed except for very weak signals. Further, if you do use a 4-stage system, do not use the 01A - use 16A, 12A, 71A. With the 16A a coupling resistor of 100K is suggested.

R-C can be added to a transformer-coupled stage using only the first AF transformer, and shunting the second. Using both results in distortion. Also, when utilizing a stage of transformer-coupled AF only two stages of R-C are needed.

As for RF amplification, the R-C type is not too efficient from 200 to 500 meters. This is because the coupling resistor is virtually shunted by the plate to filament capacity of the preceding and

driving tube. In effect, a by-pass about the resistor through which a radio frequency detours. R-C amplification, however, is **quite** effective on waves above 2000 meters, which makes it quite satisfactory for use as an IF amplifier in super-hets of the day.

Variable resistances are not necessary, although you will find one such amid the following sketches. The values are all uncritical, you will note. Any values between 50K and 150K gives almost unchanged amplification; 100K is usually the most efficient. When used with reflex input or a transformer-coupled stage, 50K is recommended for the first R-C stage.

While the 01A was generally used, other tubes will perform quite satisfactorily, and include such as 99, WD-11, D2, D3, Meyers, and "N". The Meyers tube was an excellent tube for R-C systems: not a lot are around today, it seems.

Because plate inductances and their accompanying feed-back are eliminated, the R-C system is probably the most stable of all amplifying circuits or arrangements. But it should be stressed that only *absolutely good* tubes should be used in all stages. Weak or orphan tubes are a wastage, and will almost always result in acoustic howl. Howling has also been known to occur in 4-stage systems when the last tube is cut in or out. When this happens, the last coupling resistors should be increased to the highest value giving the best results. The grid-leak can also be fine-tuned for greater stability.

R-C amplification functions with the effect of a negative bias being applied to audio frequencies - *i.e.*, the varying positive charge on the coupling side of the isolating condenser induces similar negative fluctuations on the grid side. This causes the plate curremtn to "modulate down", to decrease when the amplifier is operating so no extra bias is necessary.

Plate voltage of at least 100V should always be used. One may go up to twice the maximum potential recommended by the tube manufacturer, as the actual applied voltage is greatly reduced by coupling resistors which are in series with the plate supply. I have found that I could impress 140VDC on the plate of an 01A successfully.

When inputting from a DET tube, plate voltage of the DET should be doubled or tripled. DET plate potential should be increased until the tube detects most efficiently, or, as in the case of regenerative sets, until the set regenerates and oscillates in a conventional manner. Because of the increase in voltage phone jacks may not and should not be inserted into the DET circuit. It is a good custom to insert a 5K to 50K resistor in series with speaker leads, to lower plate current, due to the low resistance of early phones.

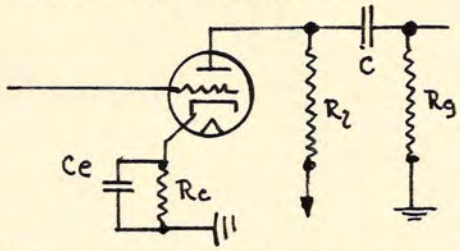
Any R-C aplifier circuitry is coupled to any type or kind

of receiver in exactly the same manner, regardless of any diversity of circuitry.

* * *

TECHNICAL & THEORETICAL DISCUSSION:

R-C amplifiers using Triodes have a frequency characteristic that is determined by the capacitance values across the plate & grid reistance & coupling condenser together the cathode by-pass. The following sketch details the constants:



Condenser C is in series with R_g. Reactance X_o varies with frequency, being largest at low frequencies, attenuating most of the lower frequencies, unless the condenser has a resistance that is small in comparison with R_g.

The plate cathode capacitance is across R_1 and the *effective* grid-filament capacitance is across R_g. These two capacitances by-pass higher frequencies, the degree of attenuation being dependent upon the size of the resistors and tube capacitances. For a fixed capacitance of a tube, the lower the resistance values the better the frequency response.

The *effective* grid-cathode capacitance of a tube is *not* equal to the static capacity, measured when the tube is disconnected via the plate supply. The grid-plate capacity is reflected back and capacity is added across the grid-leak. The total effective capacity, then:

$$C_{eff} = C_{ge} + C_{gr}\ (1+A)$$

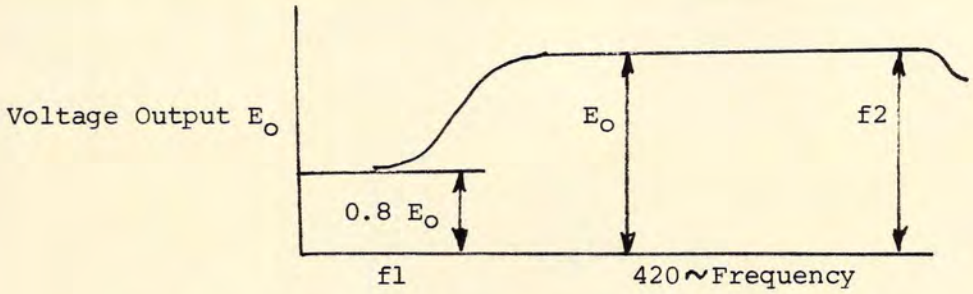
where:
A = gain in tube.
C_{ge} = grid-cathode capacity.
C_{gr} = grid-plate capacity.

The effective capacity may become large when hi-mu tubes of the early Daven type are used. When several hi-mu tubes are employed a risk arises of high frequencies being attenuated too much.

The bias resistor and by-pass condenser also influence frequency characteristics. There will be a voltage drop across then that is applied again to the grid in reverse phase. Thus, when impedance of

the combination rises, the reversed feed-back increases and output becomes less. The lower the resistance of the by-pass condenser, better is the low frequency response.

FREQUENCY CHARACTERISTICS OF A SINGLE-STAGE R-C TRIODE AMPLIFIER:



At the low end f1 = 100 cycles as 0.8 of output.
f2 = high frequency cut-off point.

When similar stages are used in cascade, voltage output at f1 will be .08 times the output at 420 cycles.

* * *

When using three or more stages, decoupling filters are required. This is not necessary for one and two stages.

The employment of self-bias has the advantage of automatic compensation for variations in the plate voltage, or slight difference in tube characteristics. Thus, self-bias is preferred to fixed bias. A variation of 10% in resistor or condenser values will have little effect on the performance of an R-C system.

Constants not previously defined:

C = blocking condenser - 1 MFD
C_c = cathode by-pass - 1 MFD
R_g = grid resistor in Megohms
R_c = cathode resistance in Ohms
R_1 = plate resistance in Megohms
E_o = Voltage output (peak Voltage)
E_{bb} = plate supply voltage in volts

When a mathematical analysis is made of the R-C amplifier a large coupling capacitor is found to be unnecessary. It is the combination of coupling condenser and grid-leak that determines the quality of the output. If the condenser is large, the grid-leak can be small & vice versa. The same frequency characteristics will obtain either way.

If a 100K resistance is used in the plate circuit, the following combinations may be used to obtain a practically flat response curve down to 50 cycles:

GRID-LEAK:	CPLNG. CONDENSERS:
0.2 Megohms	.06 MFD
0.5 Megohms	.025 MFD
1.0 Megohms	.012 MFD
2.0 Megohms	.006 MFD

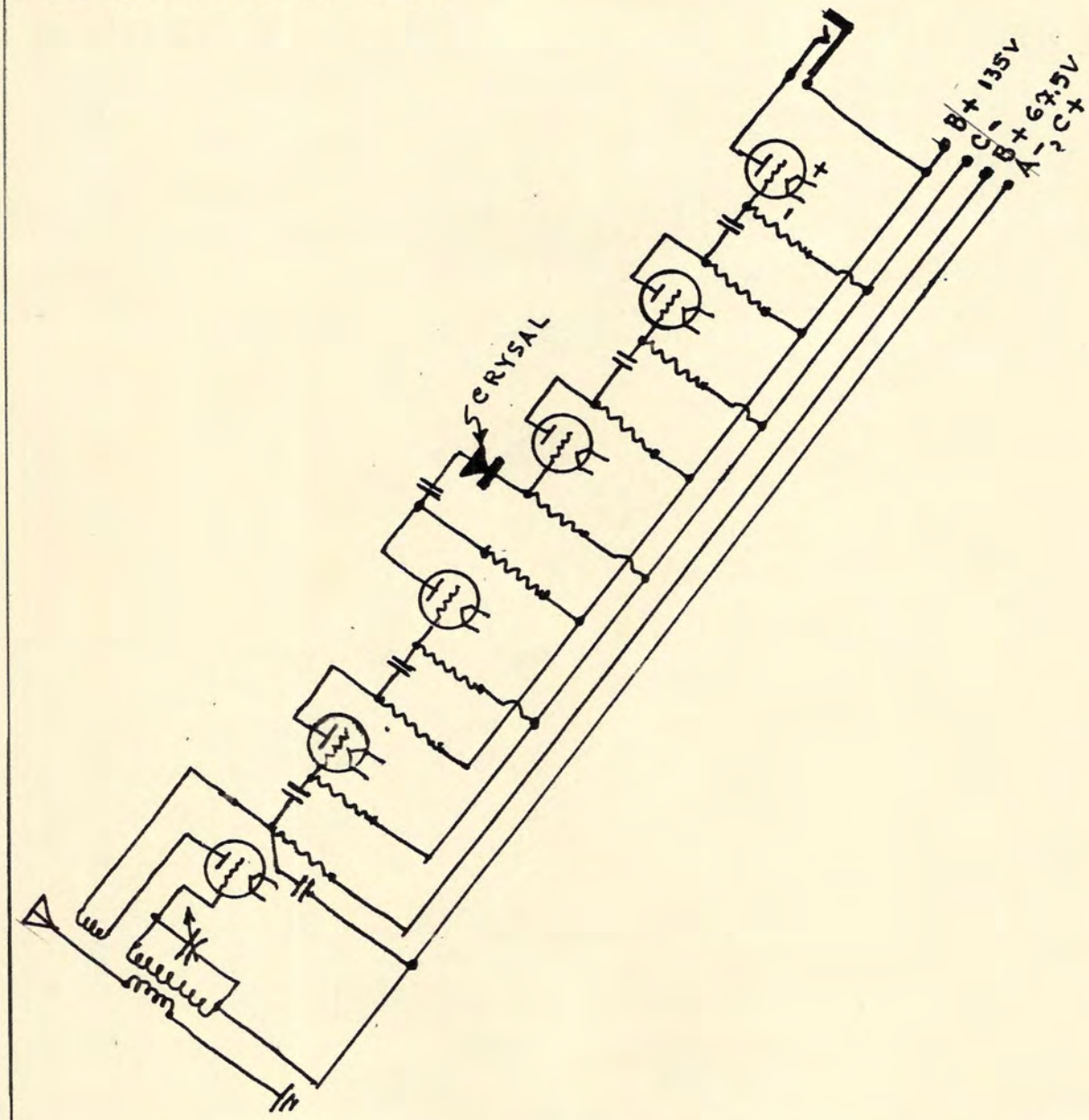
The greatest problem that seems to be attached to R-C amplifiers is due to the occasional blocking of tubes. This blocking only occurs, however, when the tube is over-loaded. This makes it essential that the proper C-bias be used on the grids of all tubes. It is quite easy to calculate the grid-bias if the circuit characteristics as well as the amplification constants of the tube is known. Such calculations would show, for example, that for a 20-mu tube the C-bias for a first hi-mu tube should not be more than one volt, and that four volts would be about right for the grid of the second tube.

Such values permit a grid being at 40 volts peak value on a 71A power tube in the last stage, for example.

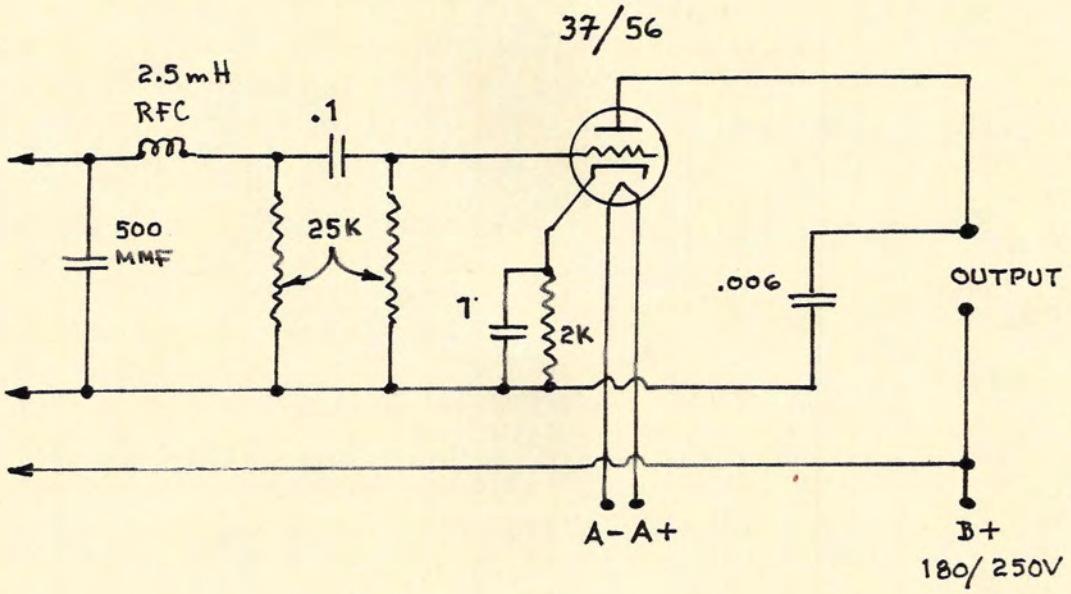
* * *
* *
*

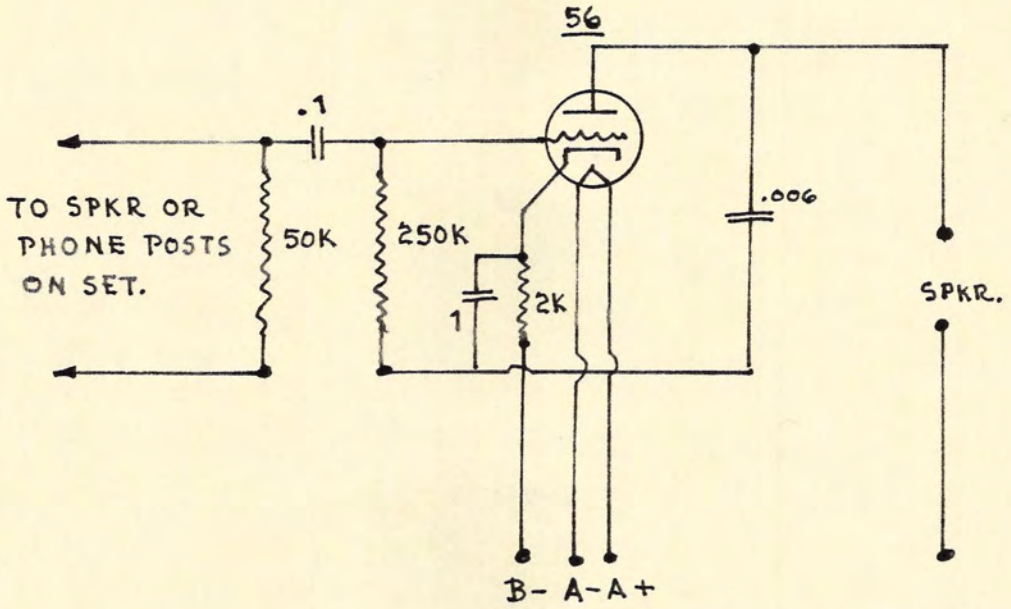
RESISTANCE-COUPLED RF WITH CRYSTAL DET.

Resistance-coupling of RF (radio frequency) was never very popular, nor was it very effective, other than as a difference. The sketch below is of a 1926 circuit incorporating RF resistance-coupling. All values were conventional for the times, and thus are not shown. The circuit is primarily of academic interest, but is not recommended as something to try, as it would be a waste of your time, and you would be disappointed in the results.

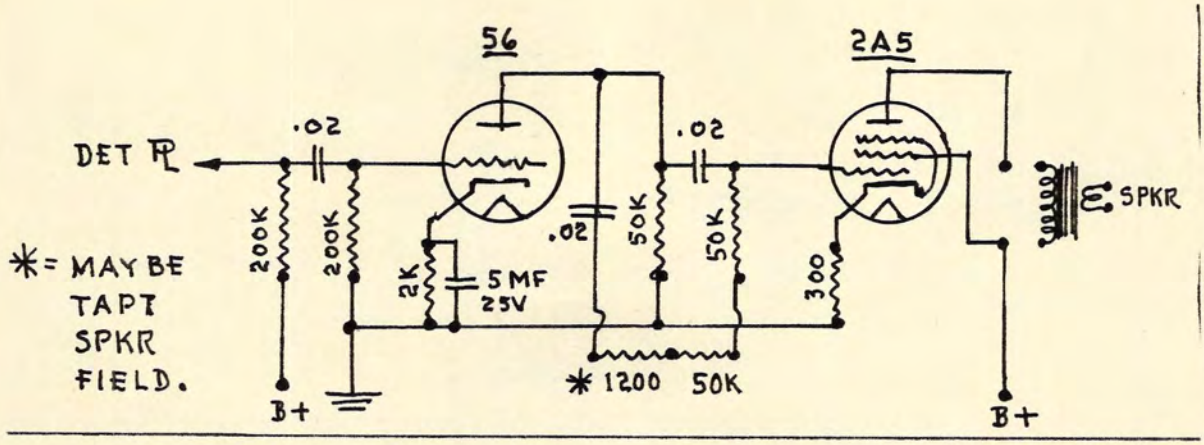


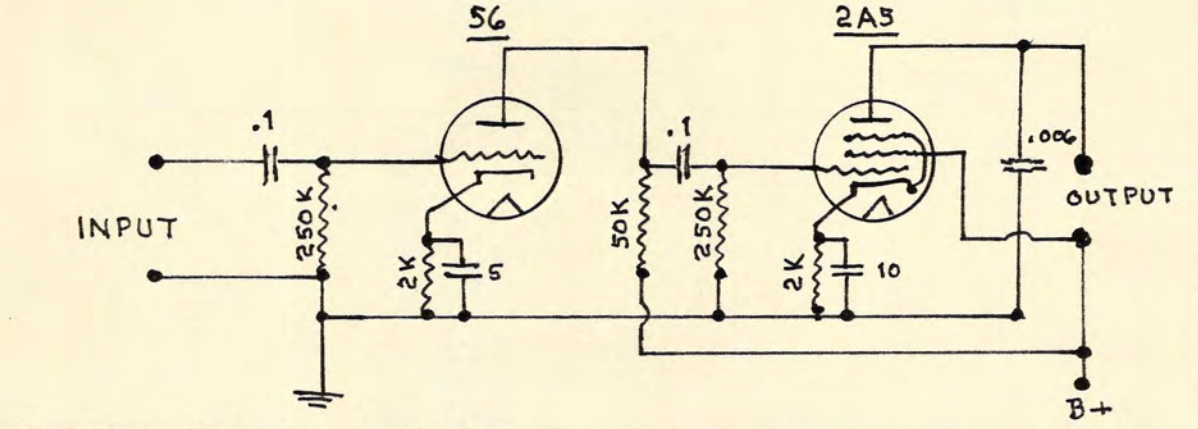
SINGLE-STAGE R-C AMPLIFIERS

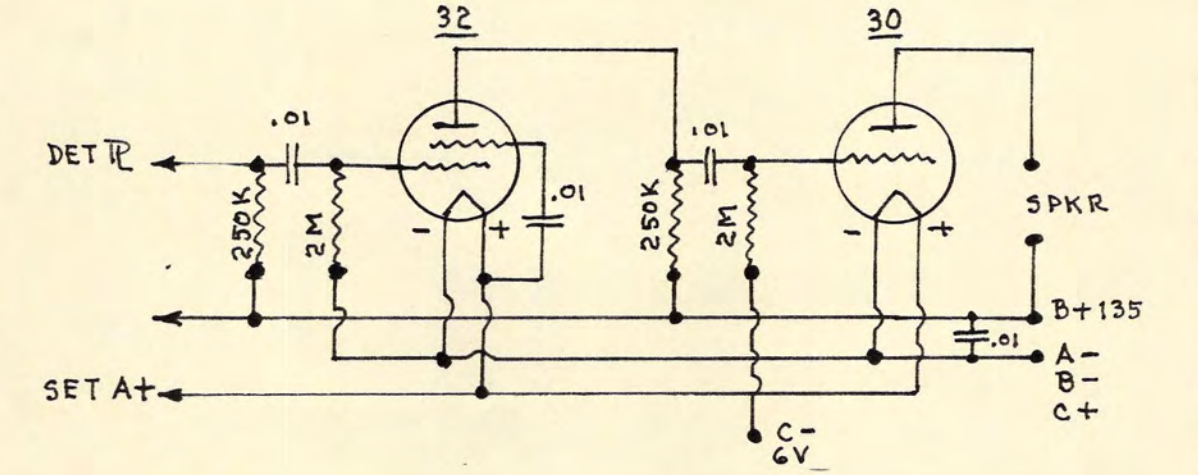


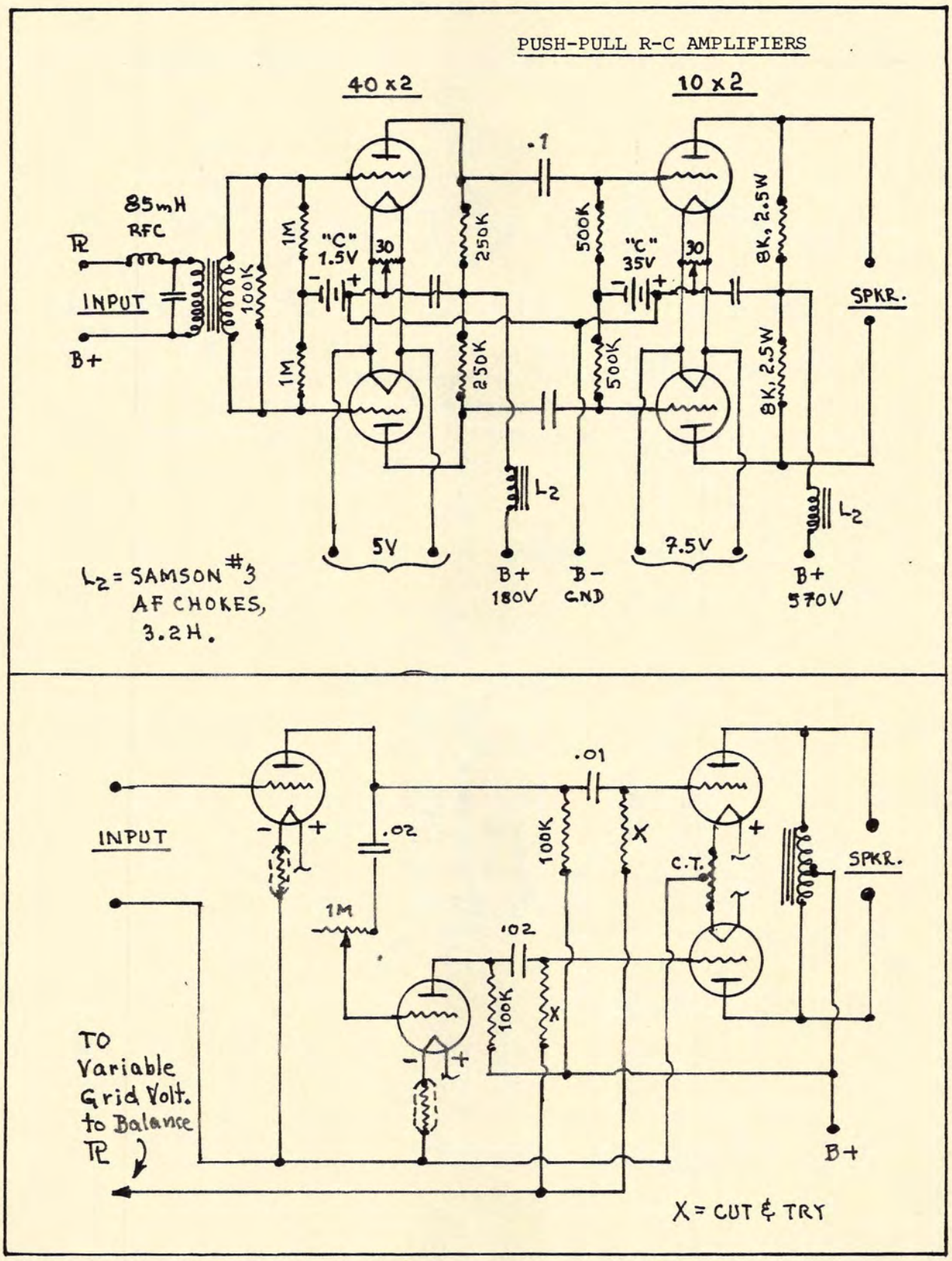


2-STAGE R-C AMPLIFIERS

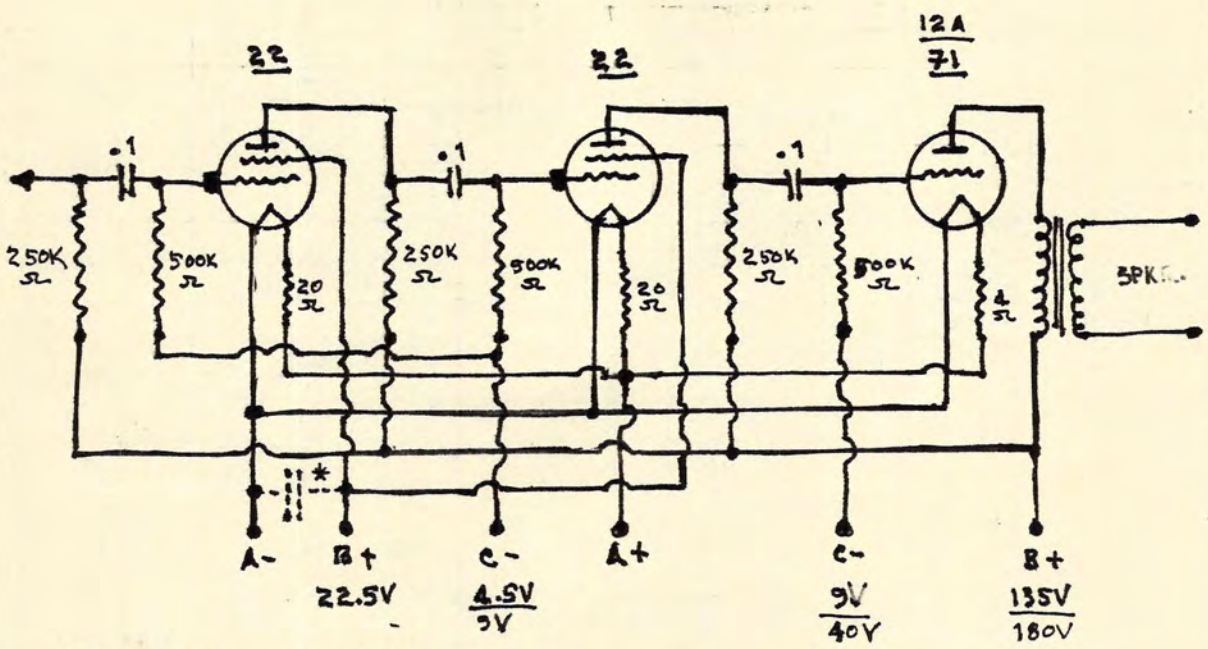




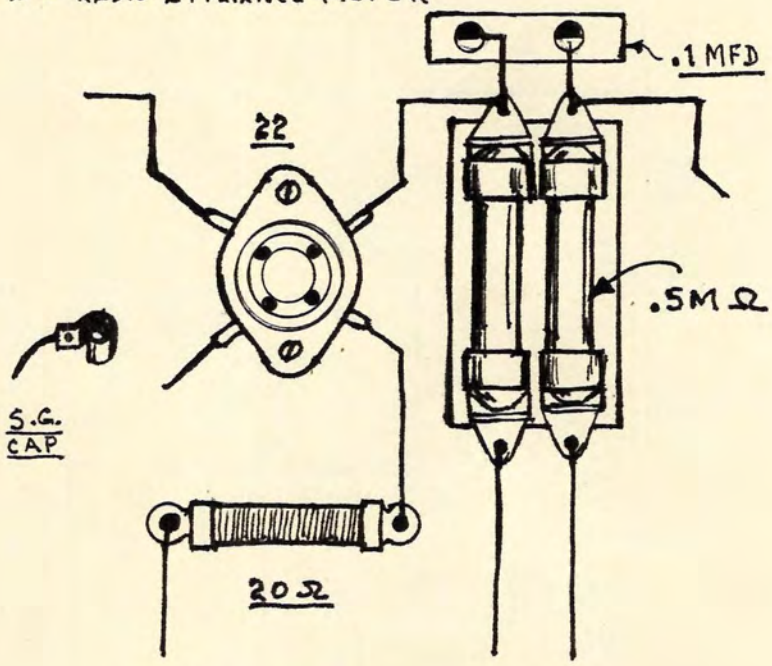



PUSH-PULL R-C AMPLIFIERS
40 x 2
10 x 2
85mH
RFC
TR
INPUT
B+
100K
1M
"C"
1.5V
30
250K
.1
500K
"C"
35V
8K, 2.5W
SPKR.
L2
5V
7.5V
B+
180V
B-
GND
B+
570V
L2 = SAMSON #3
AF CHOKES,
3.2H.
INPUT
.02
.01
100K
X
C.T.
SPKR.
1M
.02
TO
Variable
Grid Volt.
to Balance
TR
B+
X = CUT & TRY

SCREEN-GRID RESISTANCE-COUPLED AMPLIFIER,'30



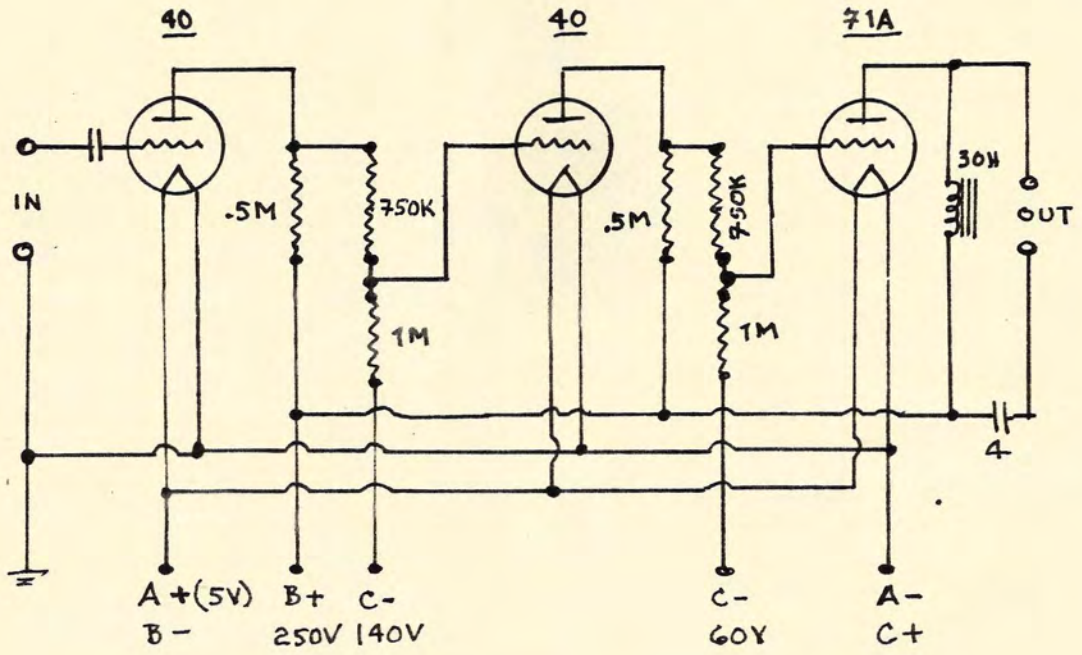
* = RADIO APPLIANCE FILTER



TYPICAL CONFIGURATION

(RN 4-30)

IRC RESISTANCE-COUPLED AF AMPLIFIER'28



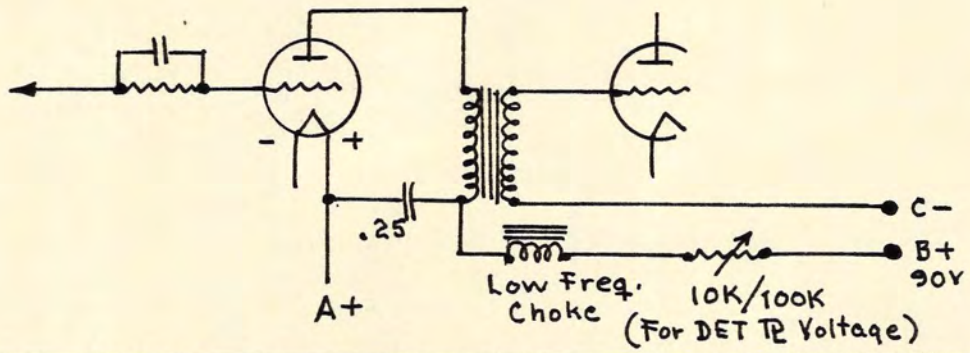
NOTES:

1. All batteries should be in series.
2. Plate and grid voltages are critical.
3. To adjust, insert a mAmeter in the plate circuits and adjust C-bias until meter shows rated current for the tube.
4. If using a B-eliminator, sufficient by-pass condensers should be placed across taps to prevent conductive coupling. (*)
5. Over-all gain is approximately the same as the usual R-C amplifier, but the frequency characteristic is flat over a longer range.

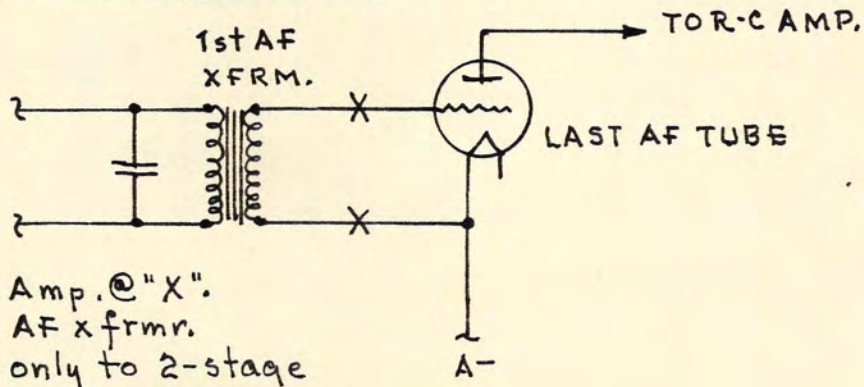
(*) = This is not necessarily true.

R-C AMPLIFIER NOTATIONS

IMPROVING XFRMR. COUPLING:

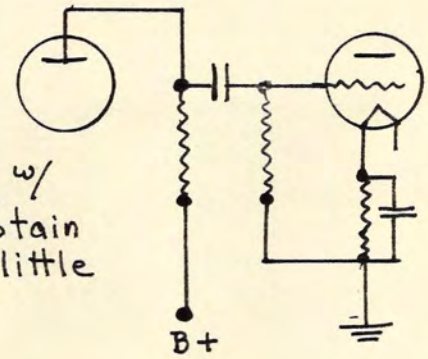


COUPLING R-C AMP. TO XFRMR.



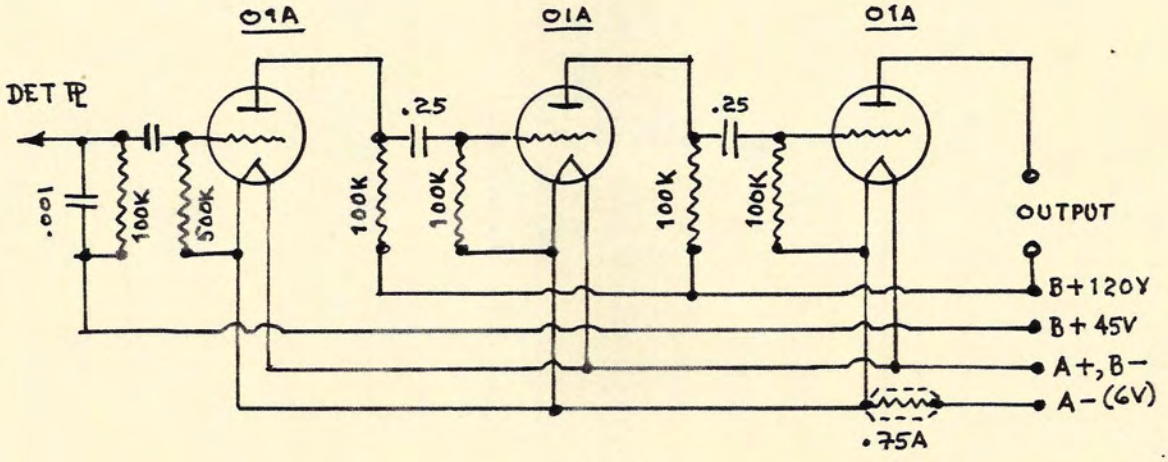
1. Couple R-C Amp. @ "X".
2. Shunt 2nd AF xfrmr.
3. Applicable only to 2-stage xfrmr.-cpld. circuitry.

TYPICAL R-C STAGE

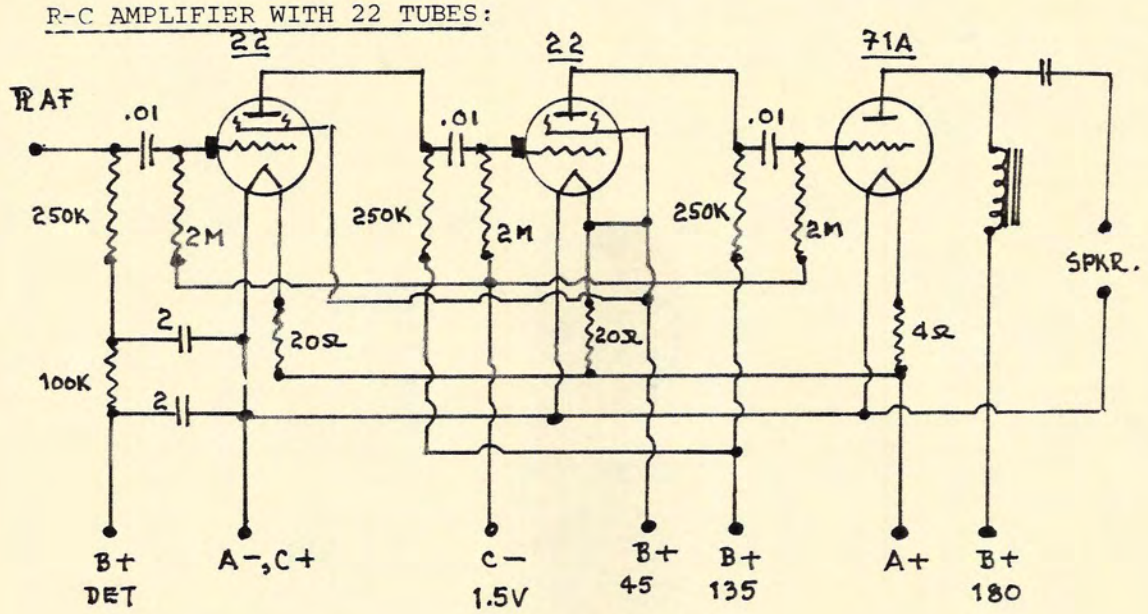


Either resistor may be replaced w/ an AF choke to obtain impedance, but little will be gained.

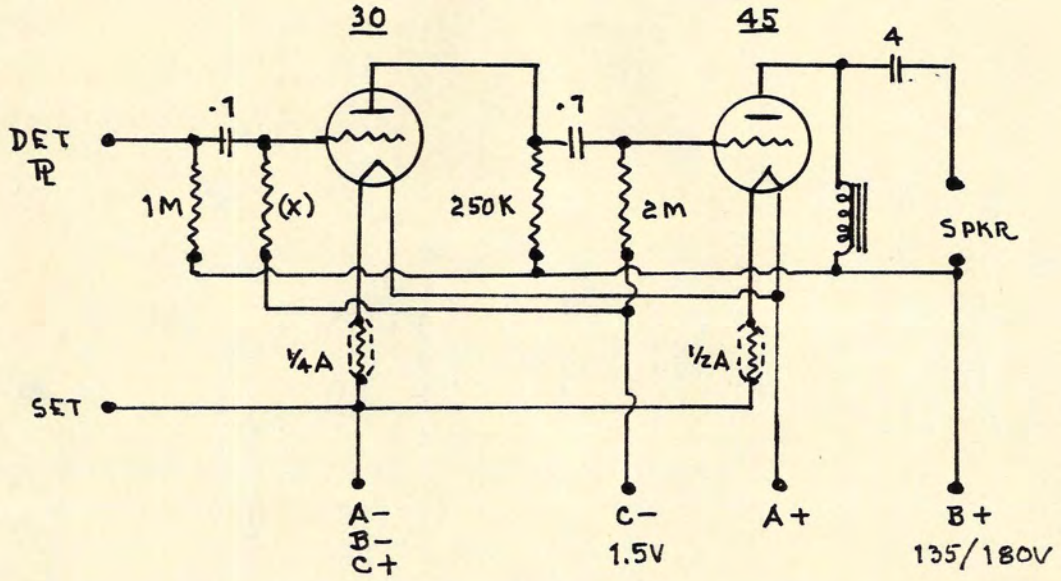
TYPICAL 3-STAGE R-C AMPLIFIERS



R-C AMPLIFIER WITH 22 TUBES:

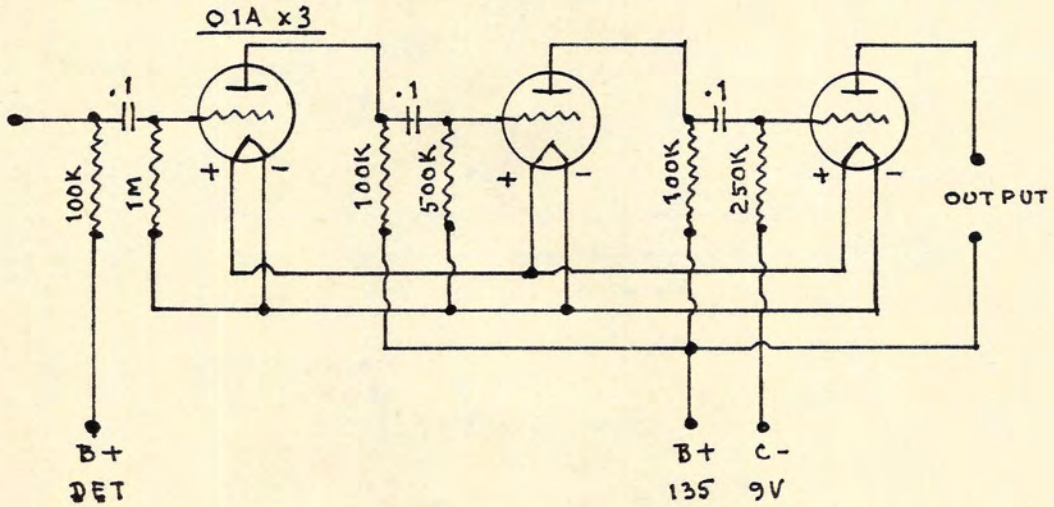


(RB 2-27/6-28)

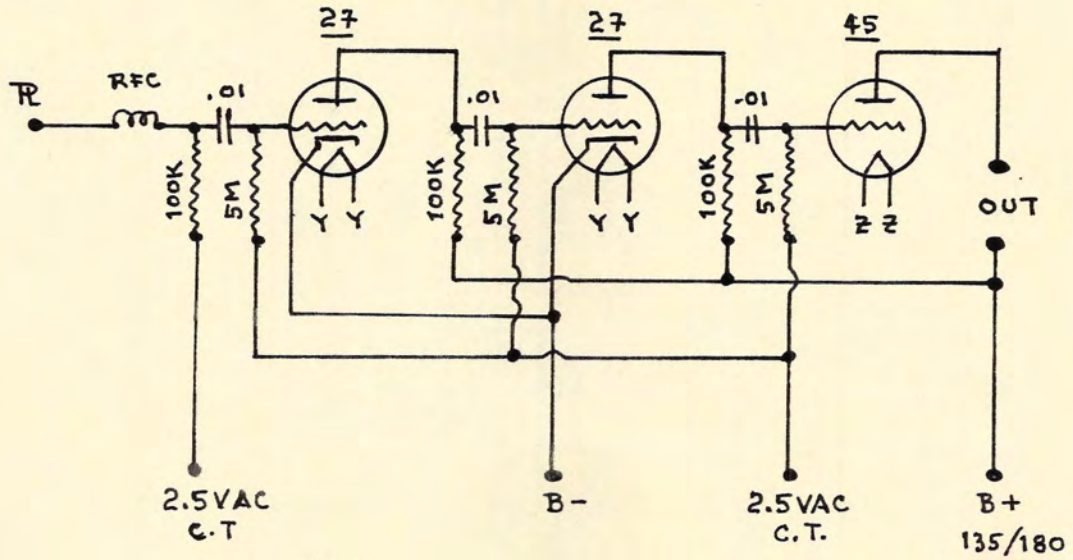


(X) = best value determined by cut-&-try.
Voltage gain depends upon tube characteristics only; a 40 may be sustituted for the 45, with 180V on the plate. The 40 tube will show a better AF gain.

H.R.N. R-C AMPLIFIER:

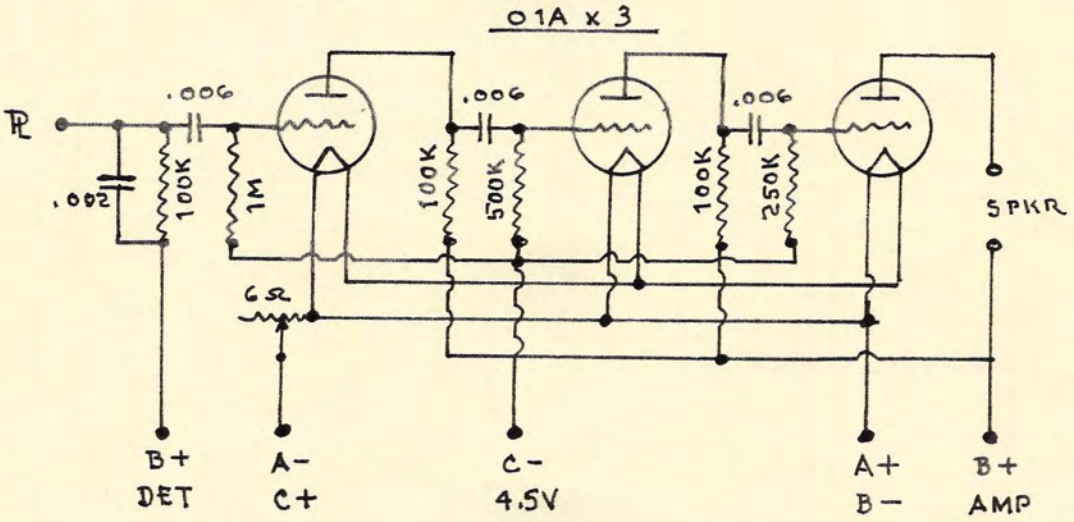


R-C AMPLIFIER WITH AC TUBES

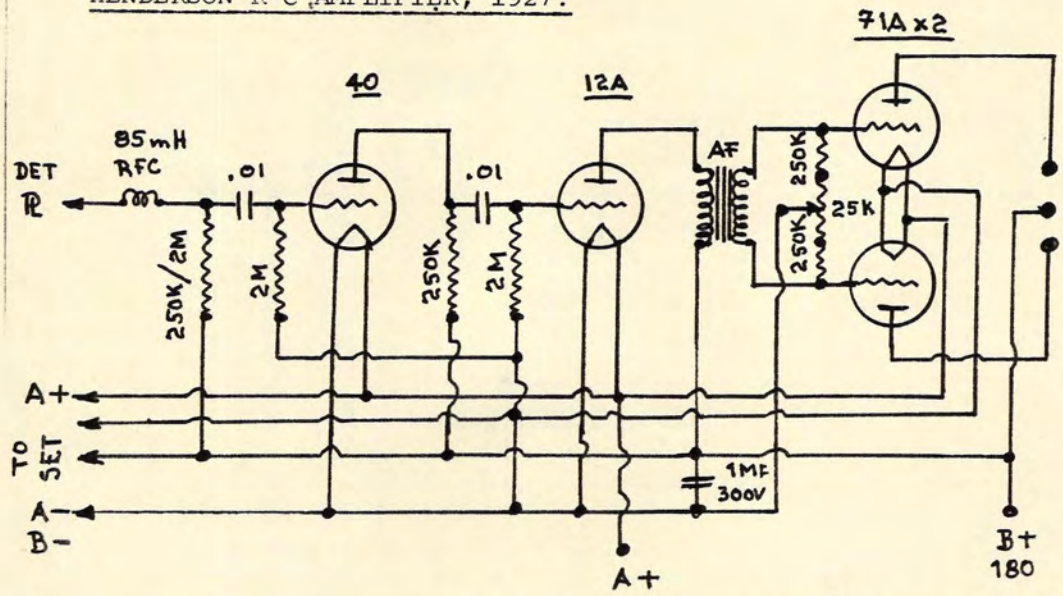


Y-Y = 2.5VAC, 3A
Z-Z = 2.5 VAC

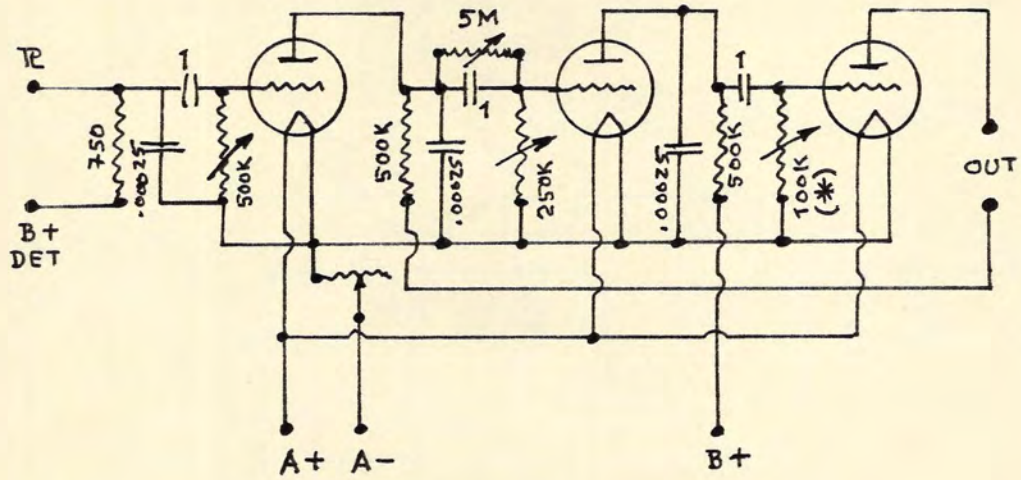
TYPICAL 3 STAGE R-C AMPLIFIER:



HENDERSON R-C AMPLIFIER, 1927:



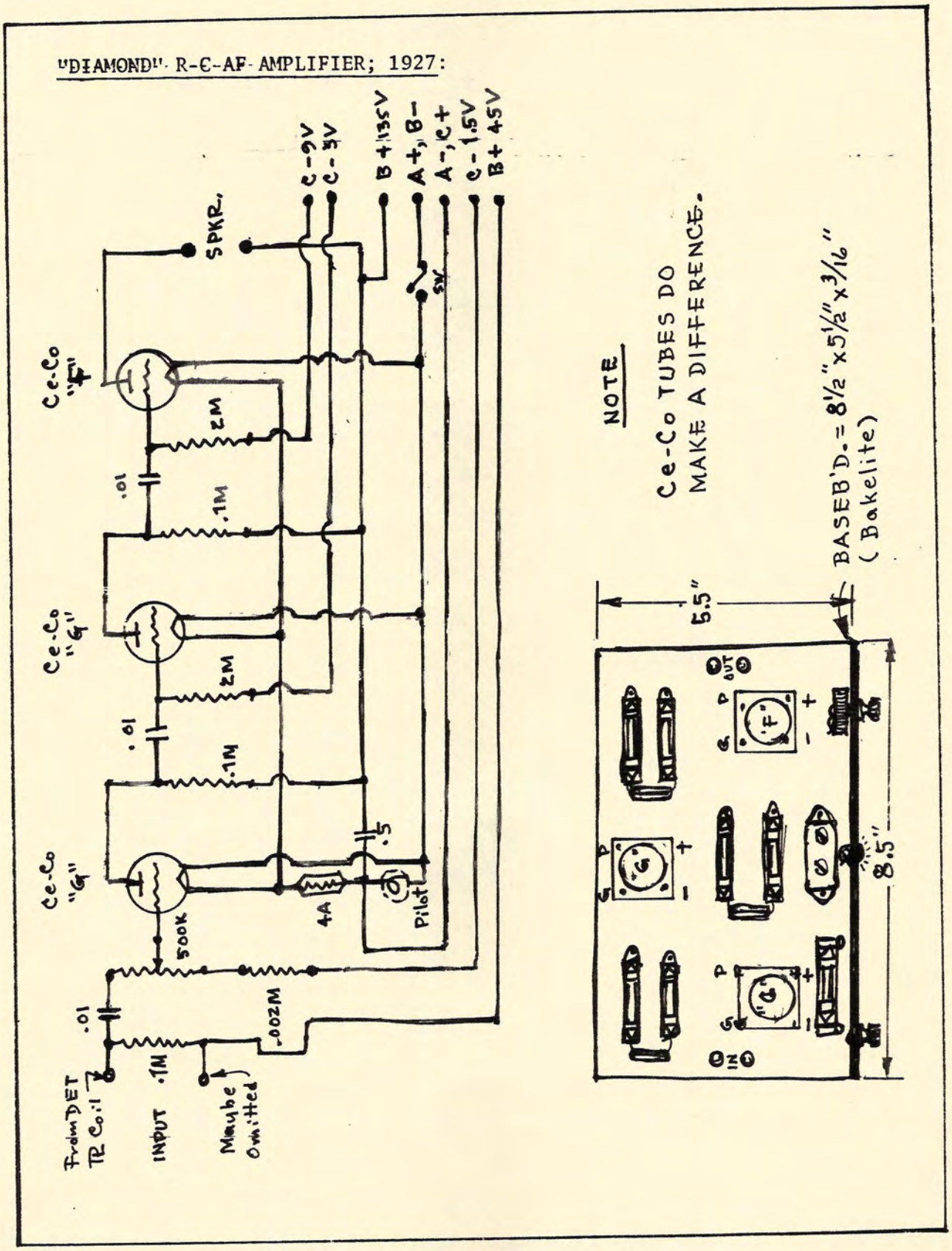
W.H.FINE R-C AMPLIFIER, 1927:



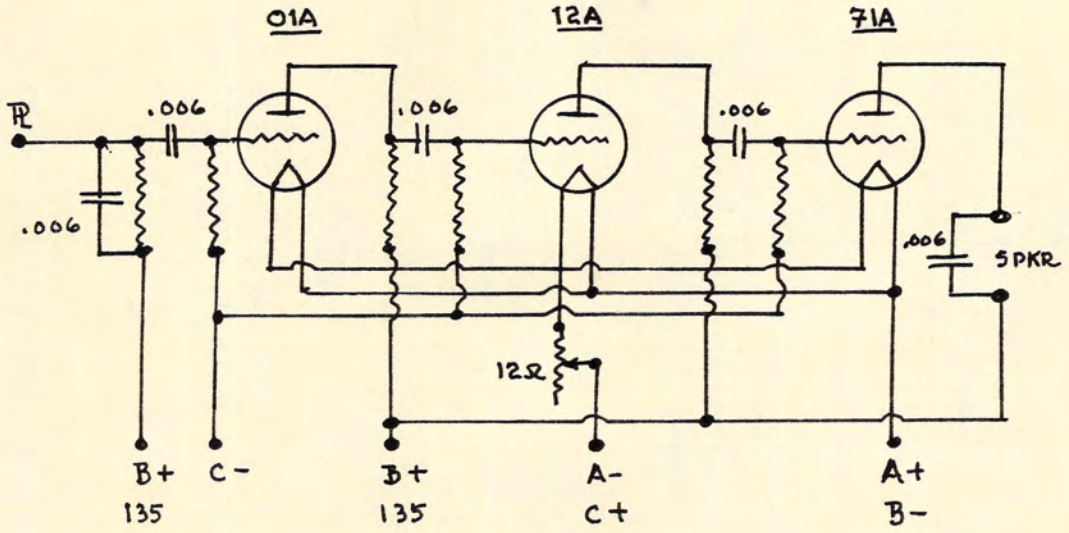
(*) = If a power tube is used, change to 50K-ohms.

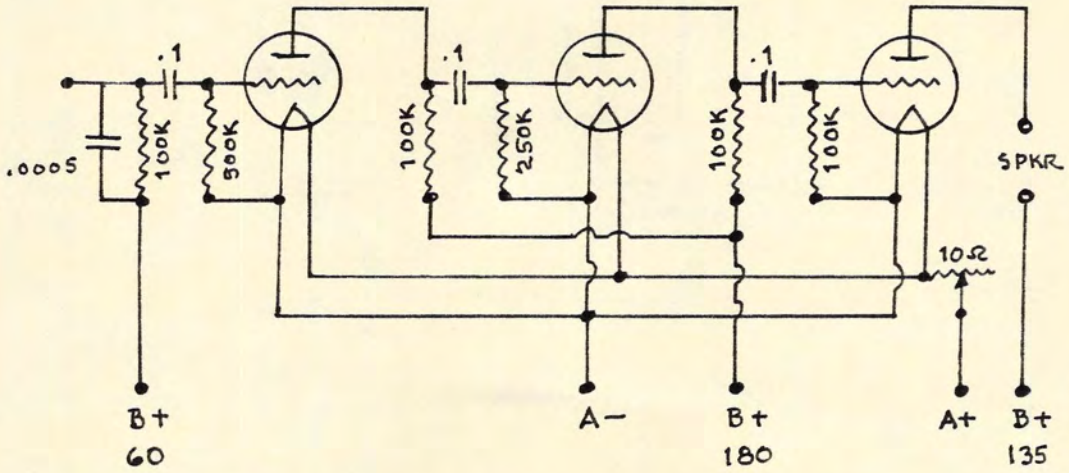
This circuit is an excellent anti-motor-boating circuit, but variable resistors are mandatory.

"DIAMOND" R-C-AF AMPLIFIER; 1927:

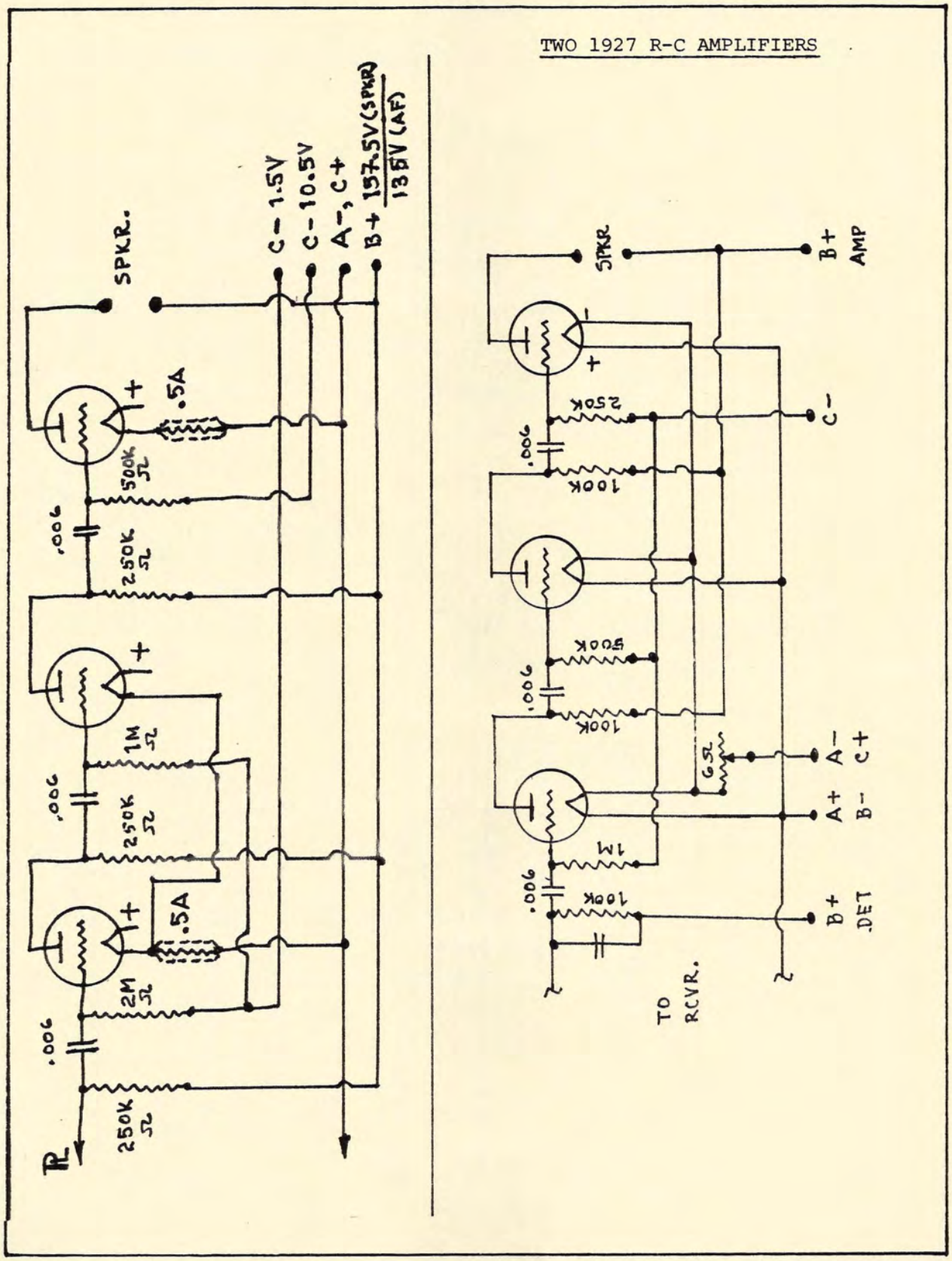


ALDEN R-C AMPLIFIERS

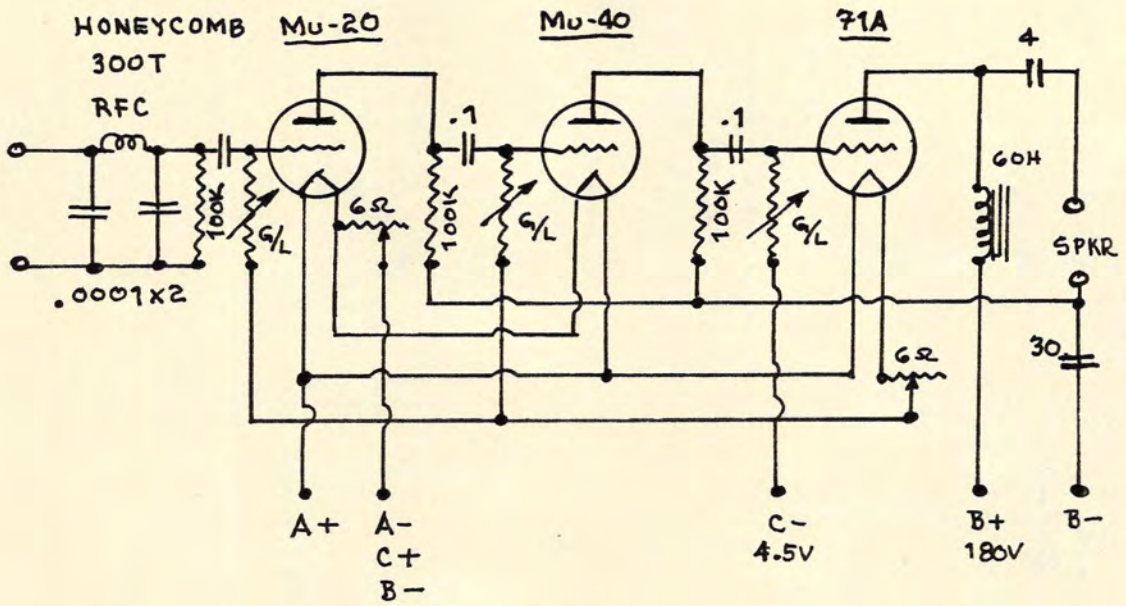




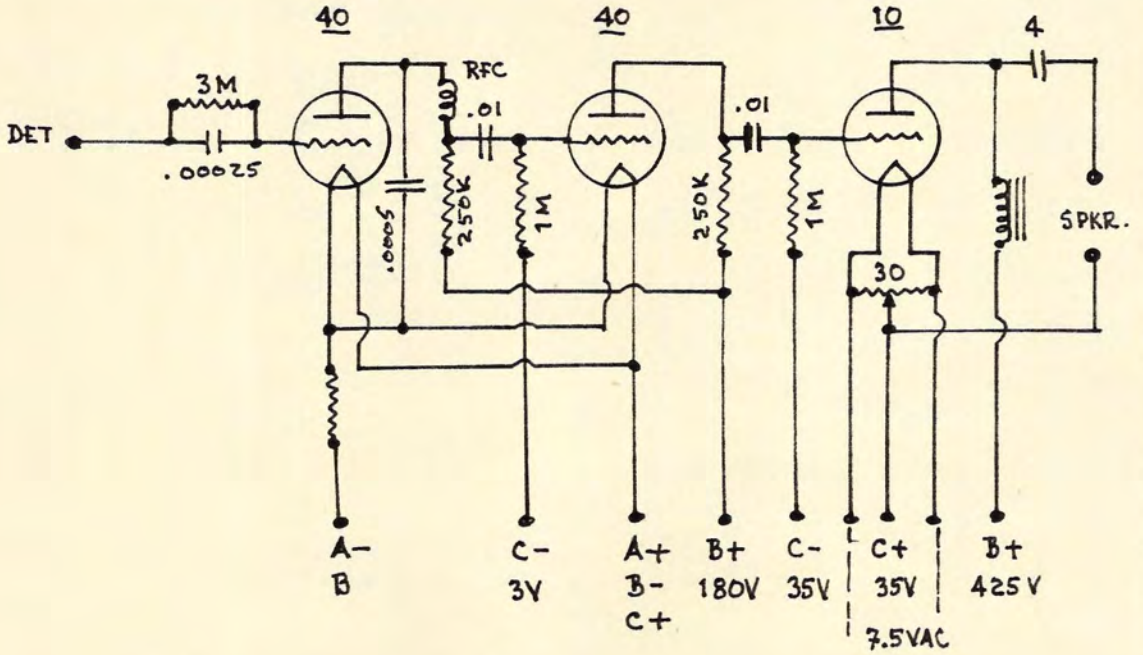
("A" STRING MAY BE TIED INTO "A" CIRCUIT of SET.)

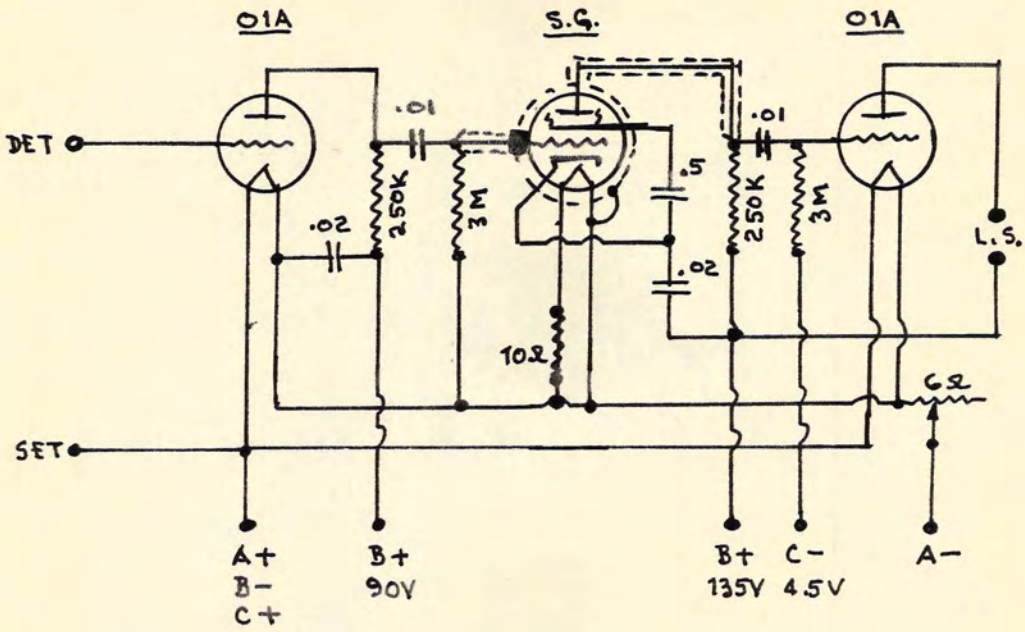

TWO 1927 R-C AMPLIFIERS
SPKR.
C - 1.5V
C - 10.5V
A-, C+
B+ 157.5V (SPKR)
13.5V (AF)
.5A
500K Ω
.006
250K Ω
1M Ω
2M Ω
R
SPKR
B+ AMP
C-
250K
100K
500K
1M
6Ω
A- C+
A+ B-
B+ DET
TO RCVR.

TWO 1928 R-C AMPLIFIERS

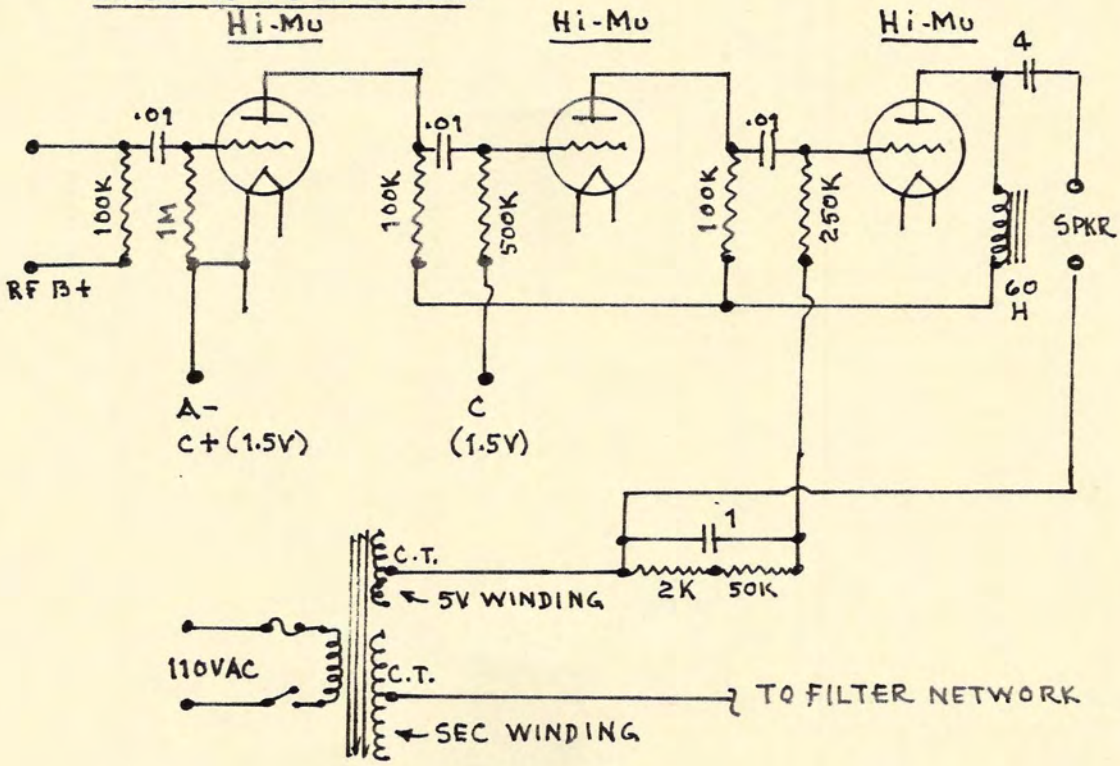


G/L = CLAROSTAT VARIABLE GRID-LEAKS (0~5MΩ).
ALL BY-PASS COND. = MICA.

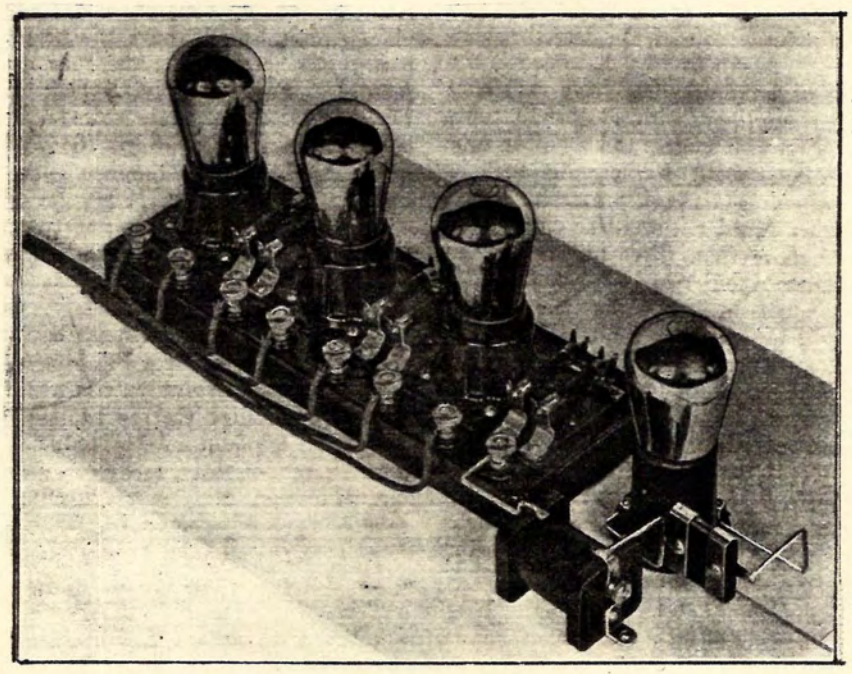




DONGAN AC R-C AMPLIFIER:



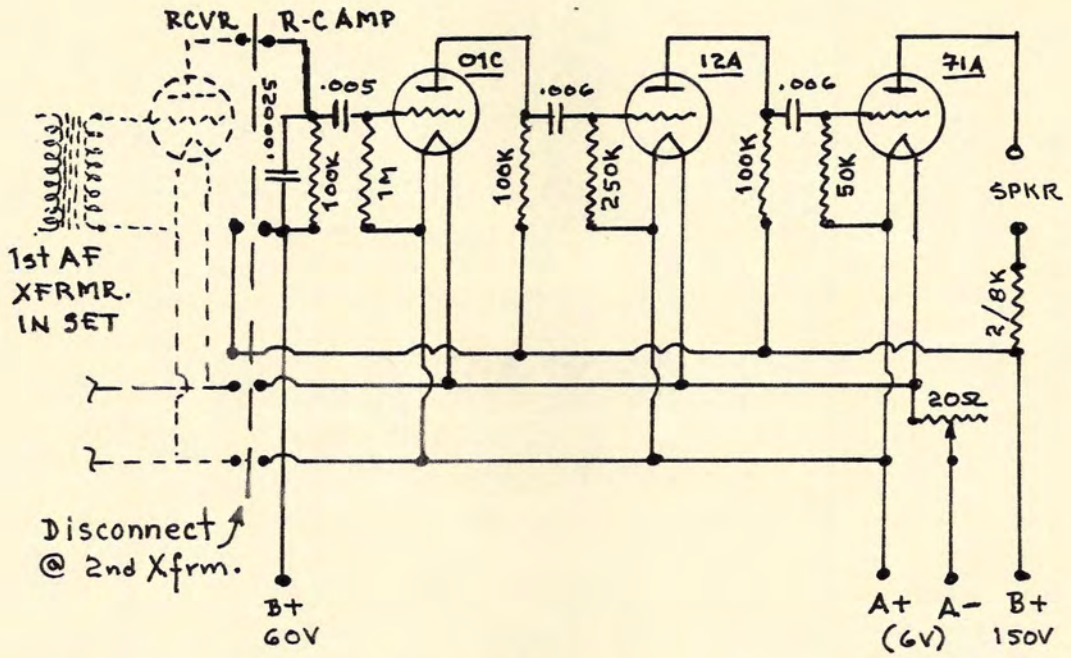
INSTALLING AN RFC AHEAD OF AN R-C AMPLIFIER



This is a very effective, and satisfying idea for use with those sets which do not have an RFC coming out of the plate of the DET.

* * *
* *
*

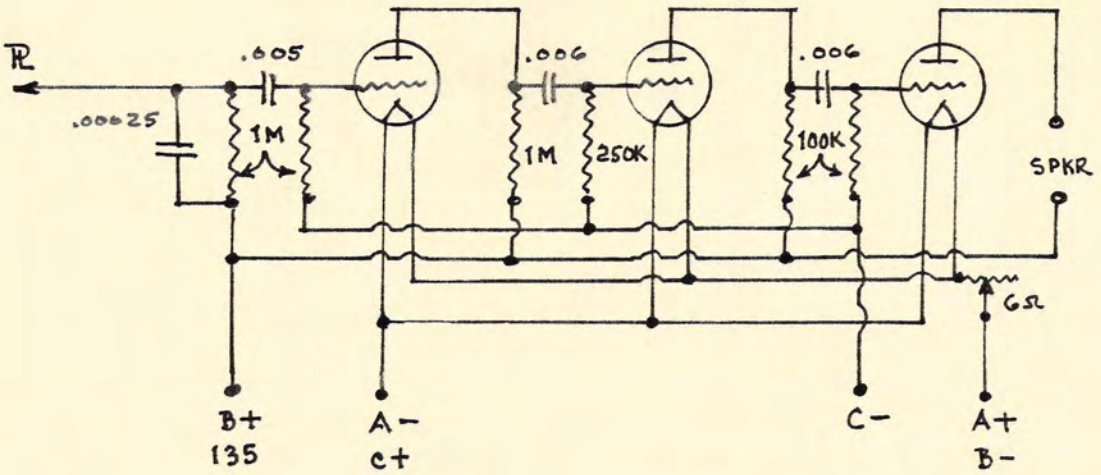
COUPLING AN R-C AMPLIFIER TO AF XFRMR. OUTPUT



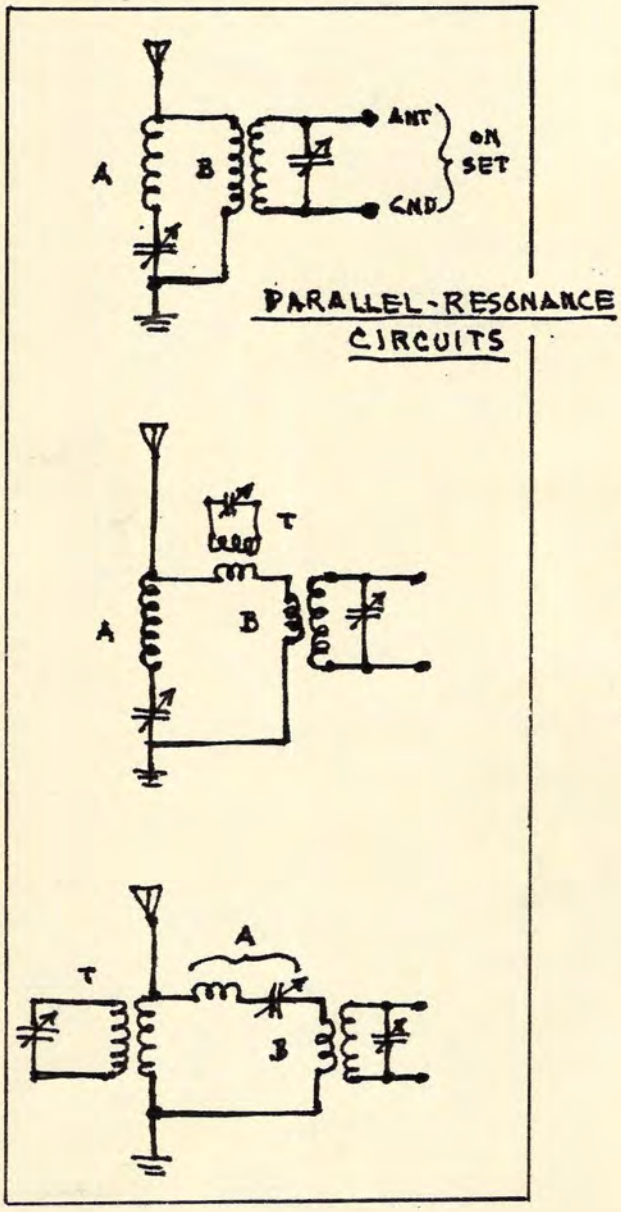
(01C = CANADIAN Version of 01A.)

BOUCK R-C AMPLIFIER:

01A x3



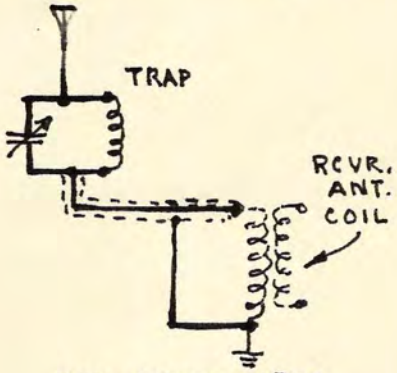
WAVE-TRAP CIRCUITRY & NOTATIONS



A = Tuned to resonance of interfering station.
T = Trap-Circuit. (1927)

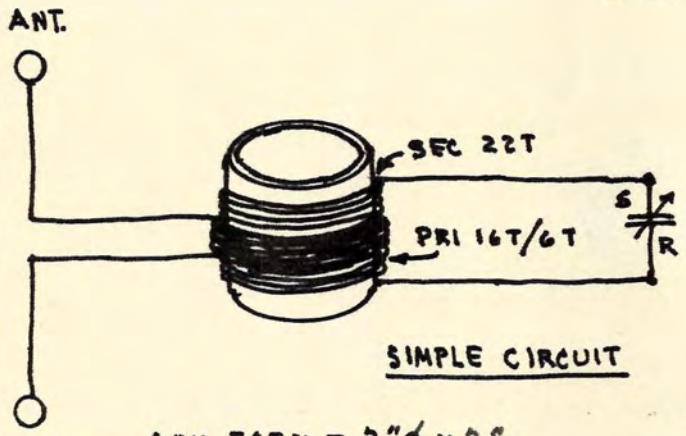
General Notes:

1. Wave-traps are REGENERATIVE circuits - not ABSORPTION circuits.
2. If shielding is used (it was not advised in the early days0 maintain at least a 2" clearance all around the wave-trap.
4. Never mount a condenser inside the wave-trap coil.
5. Use only low-loss components.
6. If shielding is desired, use copper, not brass or aluminum. Copper to be used should carry the designation #30.
7. A CW signal cannot be trapt with any of the early wave-traps.
8. There should be as little coupling as possible between the wave-trap and the set.
10. All wave-traps should be tuned very carefully.
11. The technique of using early wave-traps was to tune out the interferring station, and re-tune the set. The wave-trap was left at that setting until another interference occurred on another frequency. The wave-trap was always tuned to the resonance of the interferring signal.



FOR SUPER-HETS

WAVE-TRAP CIRCUITRY & NOTATIONS; Sht.2



SIMPLE CIRCUIT

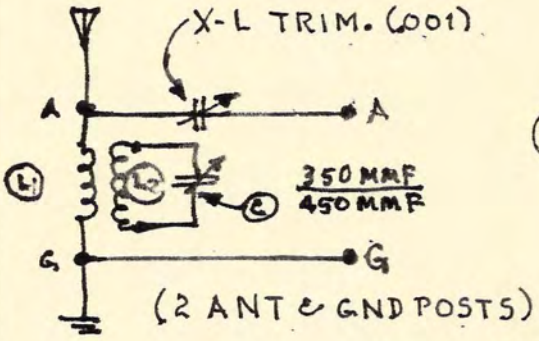
COIL FORM = 3"ϕ x 3".
43 TP VARIABLE REQUIRES 33T, #22 FOR SEC.
23 TP " " 53T, " " " (.0005)
350 MMF " " 55-60T, " " "
250 " " " 78T, " " "

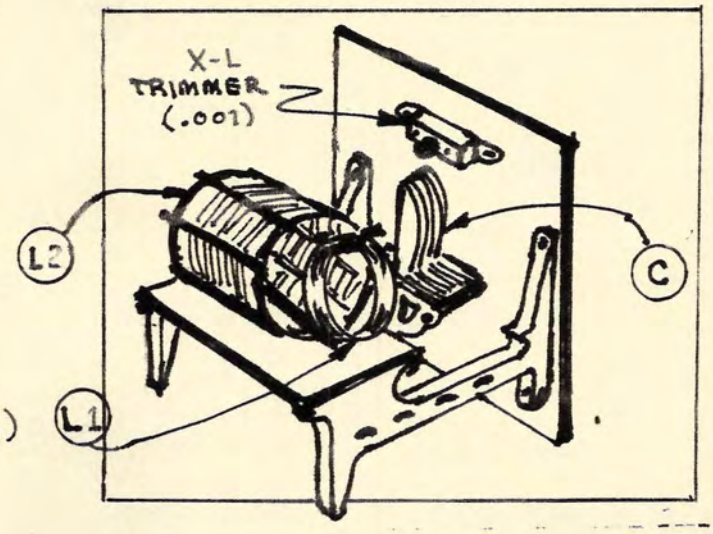
PRI = BELL-WIRE WOUND IN SAME DIRECTION AS SEC.

(1926)

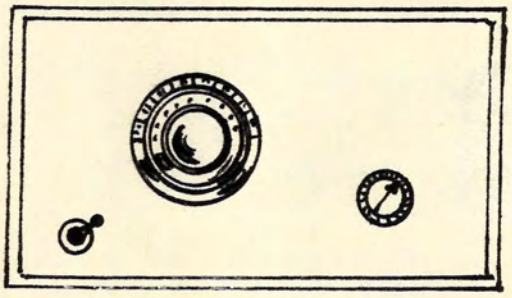
X - L RADIO LABS
(1926)

L1 = 8 Turns, #18 DCC
L2 = 60 Turns, #22 DCC

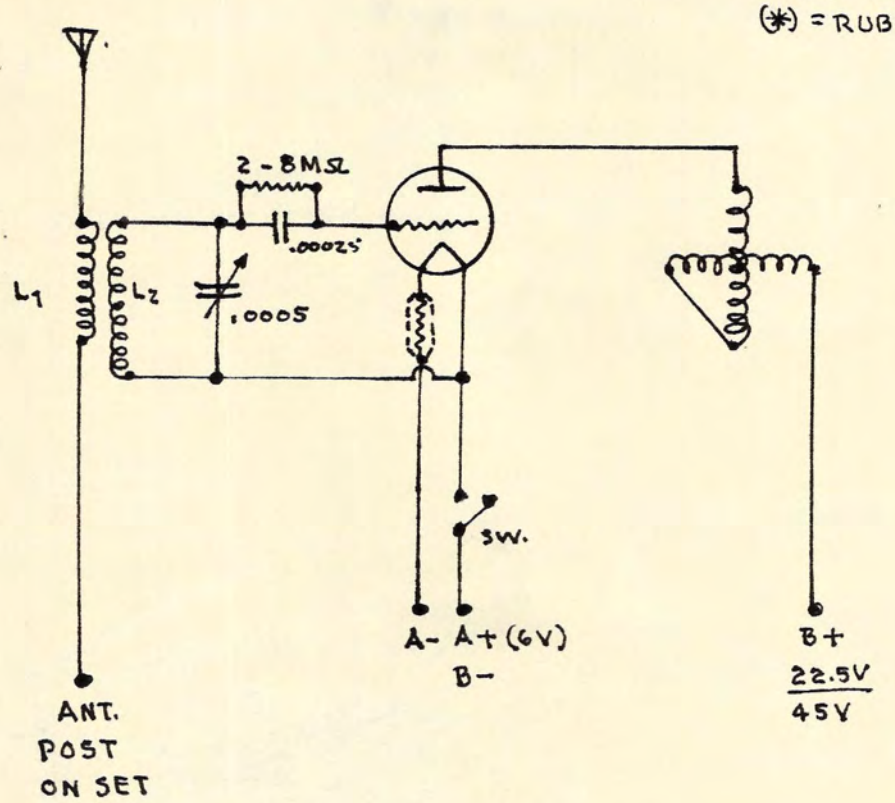




RIDER REGENERATIVE WAVE-TRAP; 1925



7"x18" PANEL(*)
6"x9" BASE
(*) = RUBBER

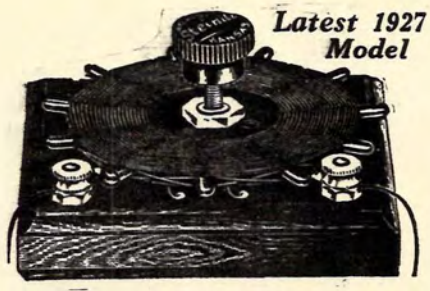


NOTES:

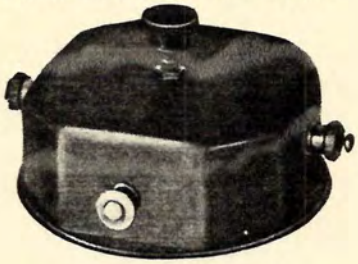
1. L1 = 2" Ø x 2" = 12 T, #24 DSC = PRI.
2. L2 = 1¾"Ø x 3" = 85 T, #22 DSC = SEC.
3. PRI was slipt over SEC and centered.
4. Original grid-leak was a Daven "Leakandenser".
5. Tube was 01A.

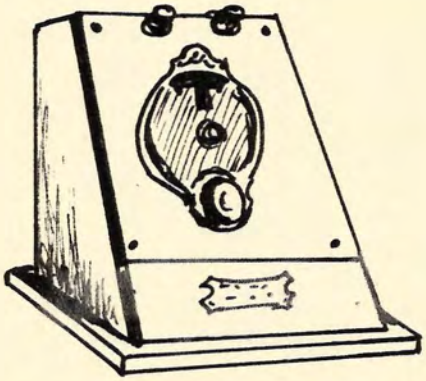
WAVE-TRAP CONFIGURATIONS

Continental Modulator No. 3

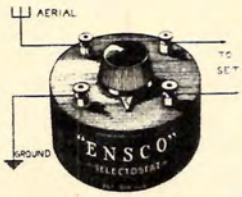


Latest 1927 Model





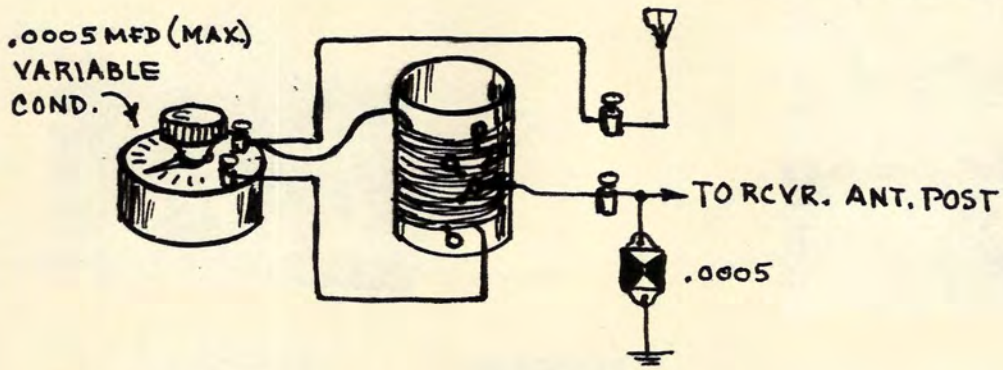
1926 WAVE-TRAP CONFIGURATION
4" x 4" x ¼" Panel
.0005 Variable shunted
by coil:
Coil Form = 3"Ø
PRI = 10T, #22 DCC
SEC = 60T, #22 DCC
(This was a home-brew.)



TRANSCONTINENTAL COIL CO.
WAVE-TRAP - 1929, $2.50

BATHGATE WAVE-TRAP
1927 - $2

A HOME-MADE WAVE-TRAP OF 1926



Taps @ 5, 10, 18, 30, 60 Turns.
Remove cottob insulation
at taps.

COIL:
60T #24 DCC
wound on 2½"Ø
cardboard form.

Mounted on 5" x 7" x ½" board.

This is a SERIES wave-trap; PARALLEL types ar different, q.v. This trap will not have any effect on psychologically non-existent interference - i.e., inaudible.

Interference over the ENTIRE band cannot be tuned out, as such interference is picked-up by the RF/IF amplifier. A thorough shielding may eliminate some interference, along with isolating power lines, line switch, and the power transformer. The once-popular "Line Filters", of which TOBE is probably the best remembered, are quite useless as far as CW is concerned.

Ground all shields and shielding material, including all shielding leads.

Note: A LOOP is more selective than a wire ANT.

THE RCA CATACOMBS

The peculiar potted catacombs of RCA in the mid-Twenties have long presented a problem to the serious constructor or restorer. There were 6-tube and 8-tube versions, and were never standardised.

Compilation of these data grew out of my own frustration from not finding usefull information in the so-called standard references; and from actually tearing down and melting our the potting material; then tracing out the bloody circuits. These methods, while obviously quite useful in the extreme, did not, unfortunately establish component values - especially where fixed condensers or resistors were open or shorted. But in the mid-Twenties - the hey-day for the RCA catacombs - there was not too much variation in component values, and they could be second-guessed quite easily.

RCA used their catacombs chiefly in the following marques:

Radiola 24	Victor 7-2 (Alhambra)
Radiola 25	Victor 9-1 (Florenza)
Radiola 26	Victor 9-2
Radiola 28	Victor 9-3
Radiola 30 & 30-A	Super-Heterodyne

Super VIII

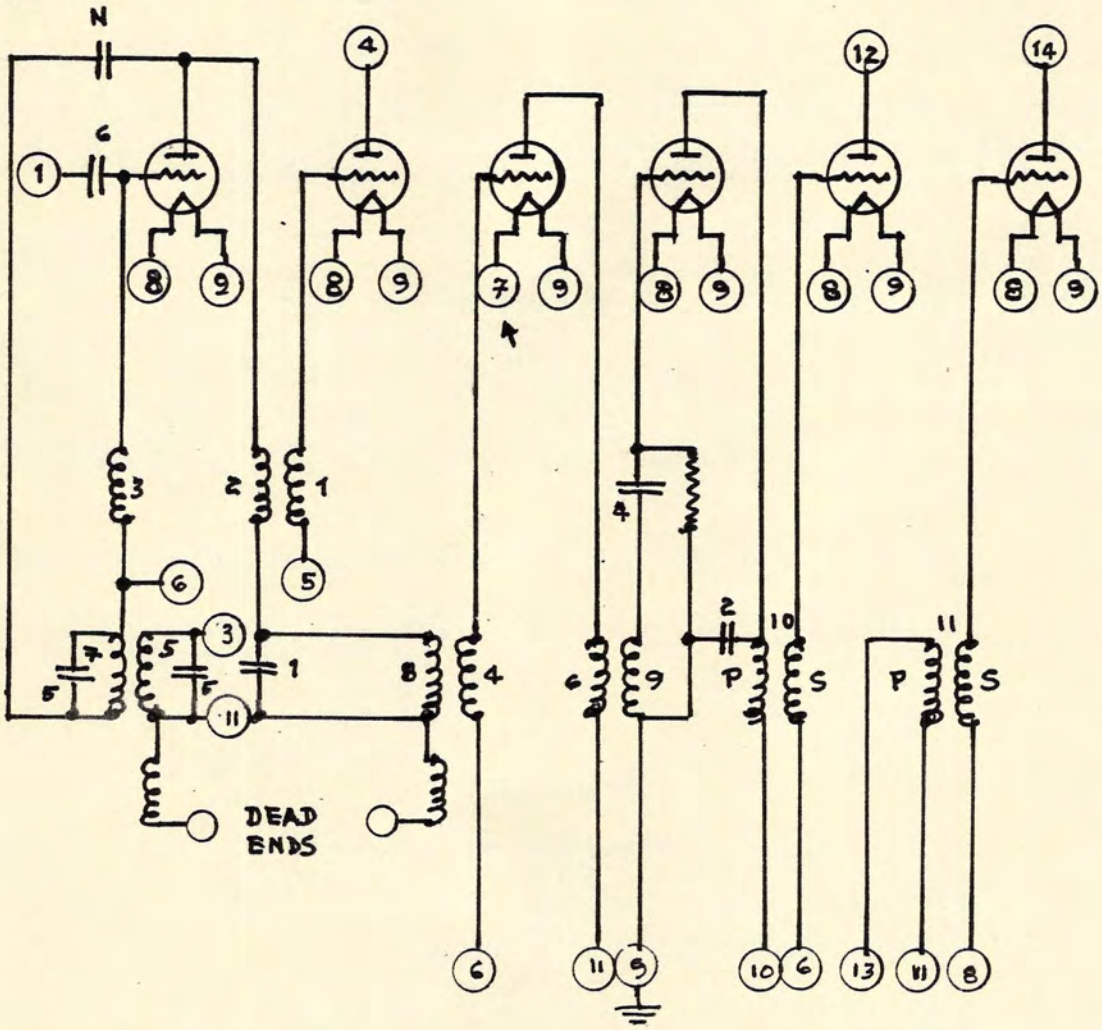
While the design concept of the catacombs was identical in all instances, they were not interchangeable between marques - which added to the confusion of early service-men. This lack of pertinent information has, on occasion, ruined many a catacomb.

The following data are offered as a guide for the bedevilled among us. They will permit you to run a continuity check on your catacomb, test the voltage at the terminal strip as originally specified by RCA, and what repairs were feasible.

Several of the battery-operated sets listed above were also adaptable to an AC-driven power supply, without altering the function of the catacombs. Those sets have been designated by an asterisk (*) after the title. AC adaptation data are not given here, but may be found in another place.

All of the following data are offered upon the assumption that you still have original connexions up to the terminal strip from the radio, itself. Some terminal strips had posts which were not used; others used a reverse numbering system, which are indicated herein. The orientation of all catacombs is the same.

RCA CONTINUITY TEST CIRCUIT OF STANDARD 6 TUBE CATACOMB

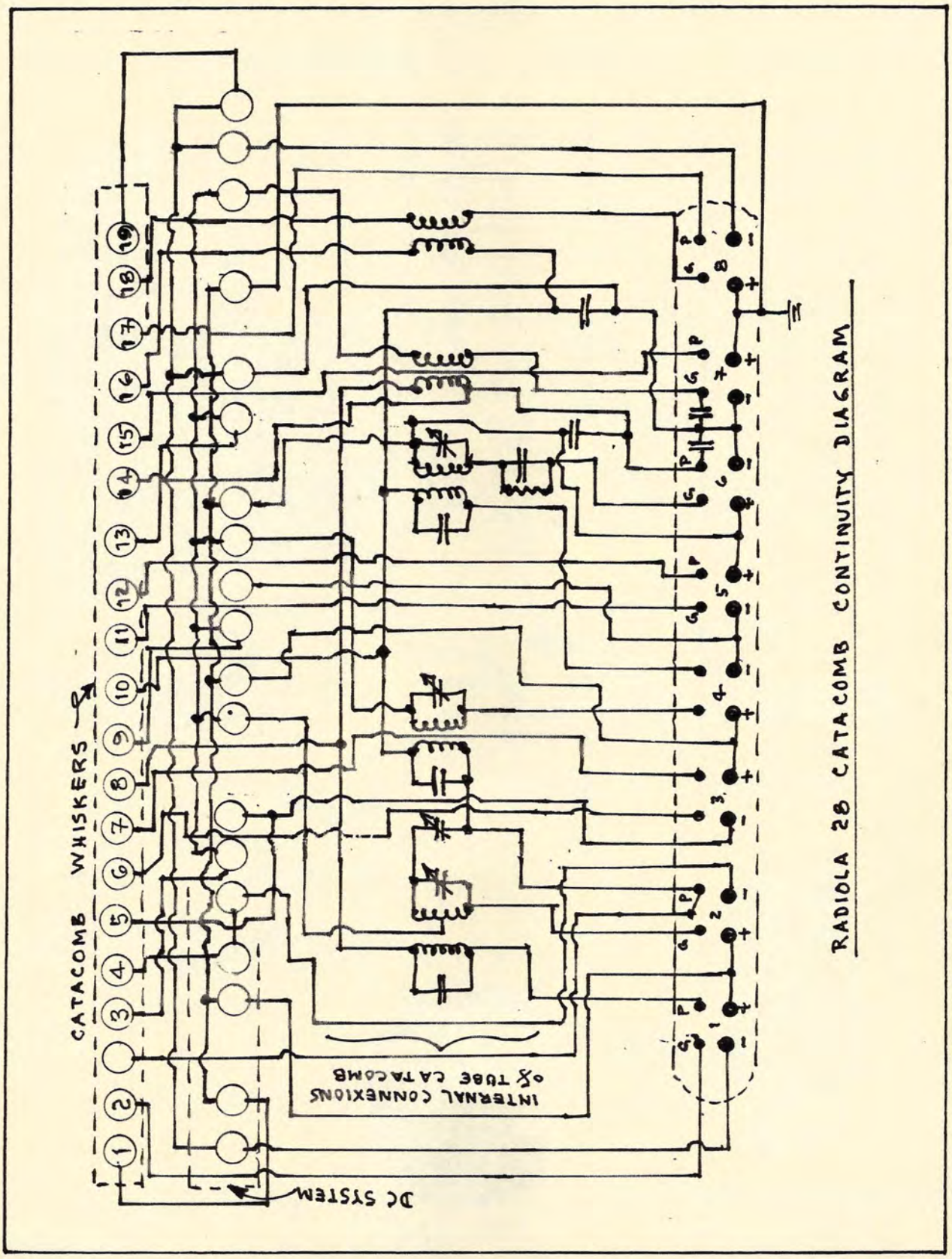


○ = WHISKERS.

ALL NOS. REFER TO ADJACENT UNITS.

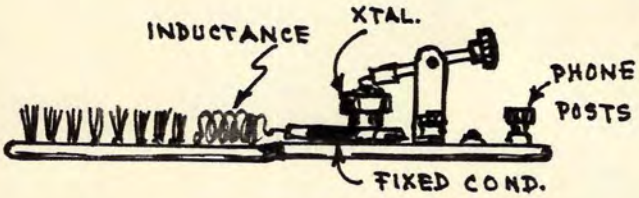
VOLTAGE READINGS TAKEN AT CATACOMB TERMINAL STRIP:

Volts:	(+) Terminal	(-) Terminal
4.5 A	12	10
4.5 C	20	7
135	17	12
90	14	12
45	13	12
22.5	20	6

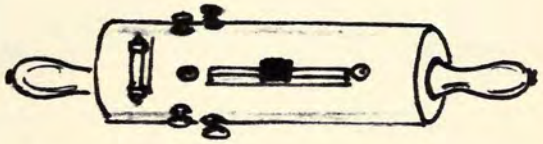

CATACOMB WHISKERS
DC SYSTEM
INTERNAL CONNEXIONS
of TUBE CATACOMB
RADIOLA 28 CATACOMB CONTINUITY DIAGRAM

CRYSTAL SET NOVELTIES

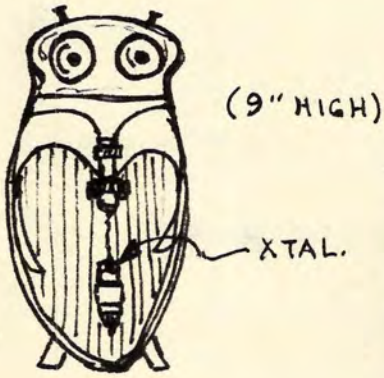
Radio novelties came into being almost at the birth of domestic Radio, and are still with us, as is obvious in the welter of transistorized pocket radio today, encased in an over-whelming array of shapes and in a multiplicity of colours. The heyday of the crystal set was not different, and novelties abounded, all being of dubious merit. At the right is a cut of the "Radiogem", a crystal set mounted atop a cardboard cylinder, wound with #28 enamelled wire tapt here and there. It retailed for one dollar in 1923. Other novelties are shown, simply to round the picture, all being of the early Twenties.



XTAL. SET ON A TOOTHBRUSH



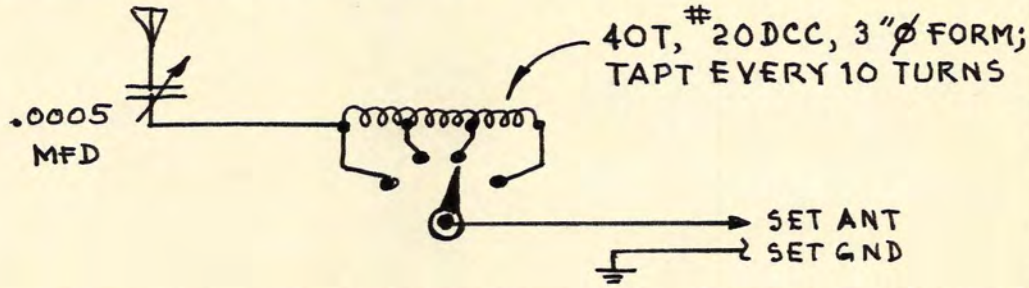
ROLLING-PIN XTAL SET
(1926)



BRUSH POTTERY CO.
(Ceramic Figure)

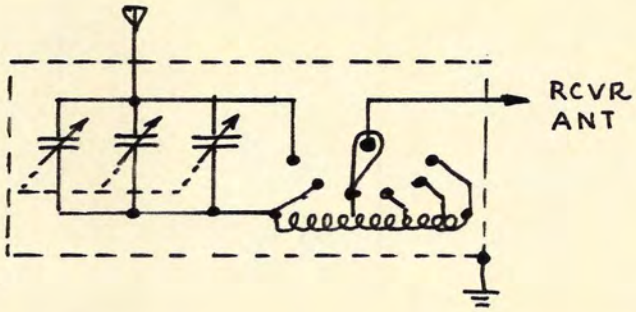
RING XTAL. SET

LACAULT AERIAL BOOSTER:

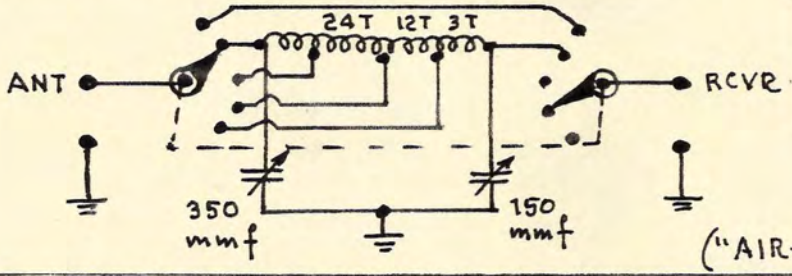


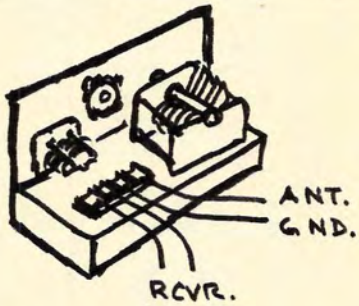
ANTENNA TUNER:

1. 3-GANG VARIABLES 350 mfd, INSULATED.
2. DO NOT GND SET.
3. COIL DATA: 150T, #24 DSC; TAPT @ 5, 20, 50, 100 TURNS.



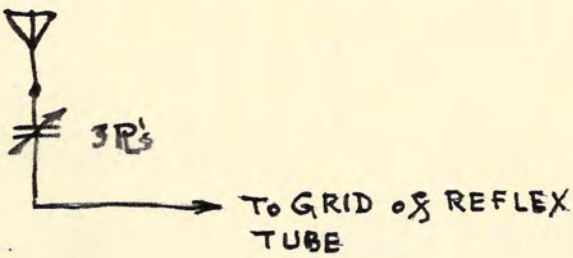
ANTENNA SWITCHING COUPLER:



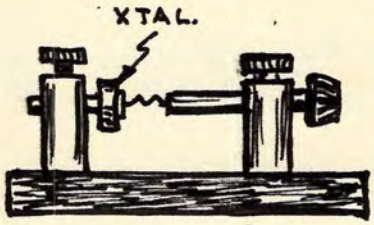


("AIR-DUC" 1"Ø x 3")

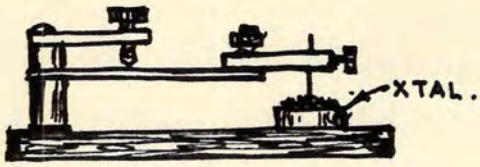
HARKNESS REFLEX ANTENNA ("SENSITIVITY") CONTROL:



EARLY CRYSTAL DETECTOR CONFIGURATIONS:



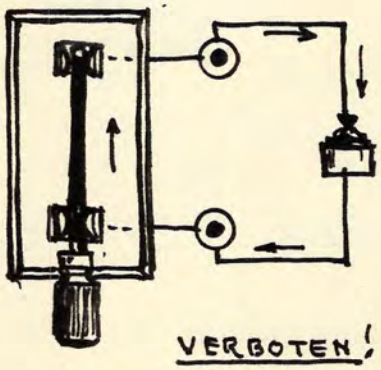
GALENTA XTAL.



CARBORUNDUM DET.

END VIEW

SILICON DET.



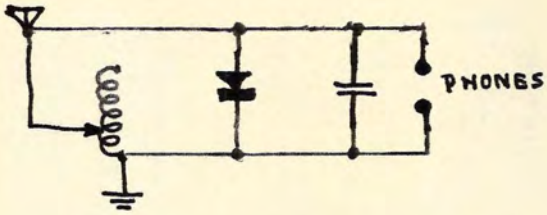
VERBOTEN!

shunting a xtal. w/ a switch forms an oscillating circuit, & should never be employed.

GENERAL NOTES

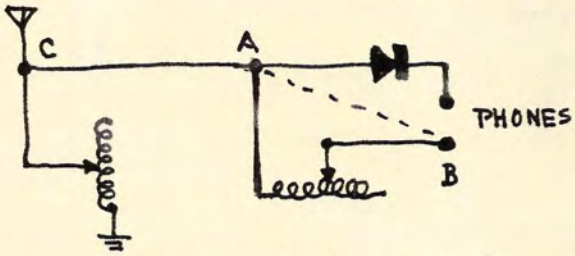
1. Base must be rigidly mounted and the whisker lightly mounted.
2. The Galena crystal has a smooth face and is ideal for Fig. I.
3. Galena whisker should be moved with a pencil-point, then tightened in best position.
4. Galena is more sensitive than Silicon.
5. The carborundum detector arm will rebound with vertical vibrations and undergo tortion in the horizontal plane.
6. Carborundum and zincite-bornite did not require much delicacy of design.
7. The sensitive spot of a crystal can be burned out through a strong signal, or the effects of a local transmitter.
8. A common error was to short-out the crystal while transmitting, which quickly became self-defeating.
9. Best procedure while transmitting was to disconnect both sides of the crystal from the circuit.
10. Crystals should be covered with a metal box or a Bakelite cover lined with tin-foil, placed gently over the crystal after adjustment.

A BASIC CRYSTAL DETECTOR CIRCUIT:



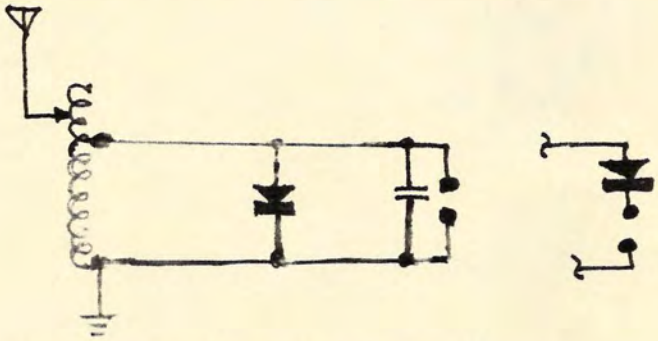
Oscillatory circuit composed of ANT, a variable inductance, and GND. The crystal was connected directly across this.

A UNILATERAL EXPERIMENTAL CIRCUIT:

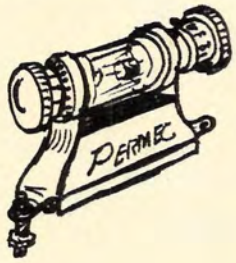


"C" must be tied at both "A" and "B". This hook-up will function only at one or the other.

ALTERNATE TO THE BASIC CRYSTAL DETECTOR CIRCUIT:



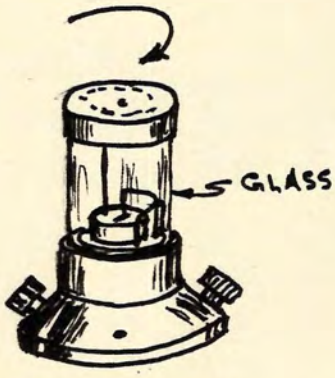
A UNIQUE BRITISH CONTRIBUTION:



A rather sophisticated crystal detector from England, with a large glass tubular encasement, and dials for calibrating and logging signals. (1926)

(Refer to Vol. VIII for crystal set circuitry and configurations.)

EARLY CRYSTAL DETECTORS

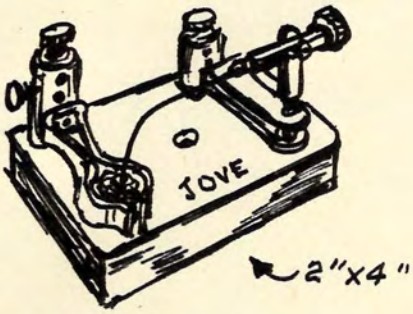


"YELLOWTIP"
WHOLESALE RADIO
(1923 - $2)

XTAL.
TUBE DET.
B-METAL
(1923 - $1.50)

"GREWOL"
RANDEL WIRELESS
(1923 - $2)

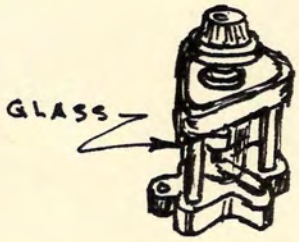
STANFORD RADIO
(1925 - $1)



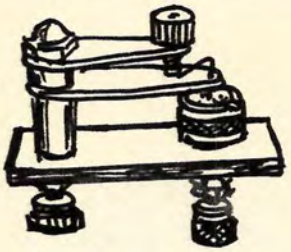
JOVE XTAL. DET.
(1919 - $1.44)

ACS
XTAL. SET
(1921 - $5)
200-600M

"RASLA"
DAVIDSON RADIO
(1923 - $1.25)



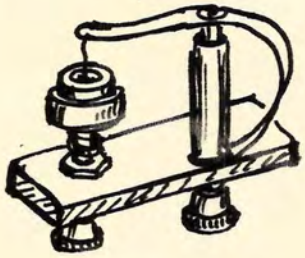
FRESHMAN
(1925 - $1.50)



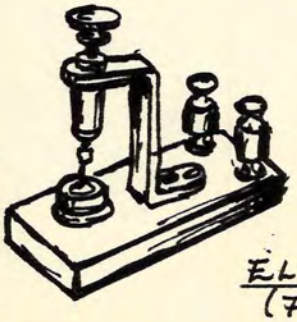
ARGENETTE
(1925)

CARBORUNDUM

WELTY
CRYSTECTOR
Plug-In Type
(1924 - $4)

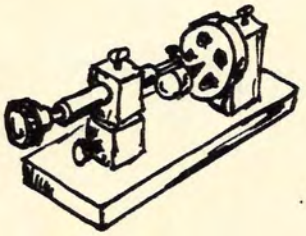


TANNER
(1925)

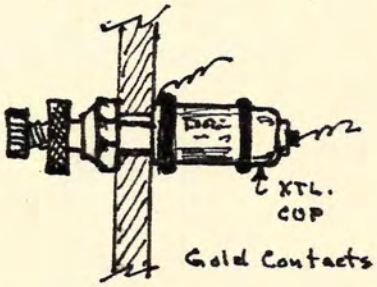


ELECTROLYTIC
(Fassenden)
(1908)

FADA
(1922 - $2.25)



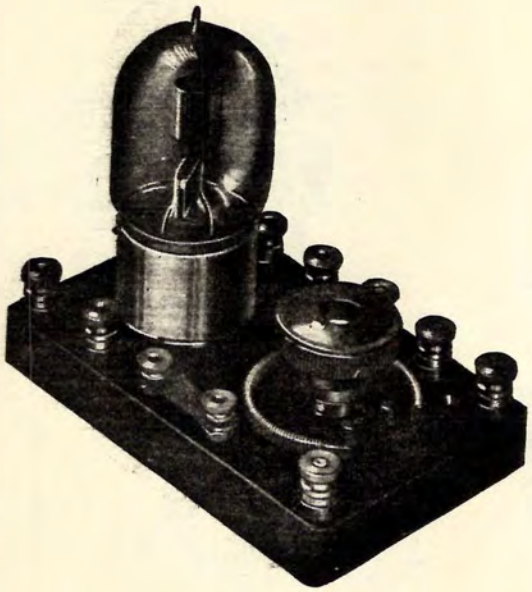
BORNITE-
ZINCITE
4-Position
(1916)

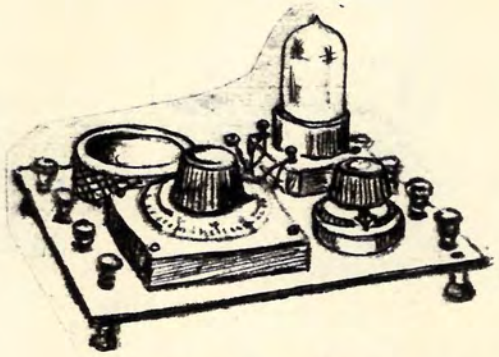


FOOTE "Variodenser"
(1924 - $1.75)

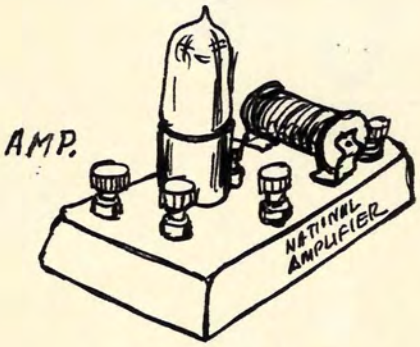
AYLSWORTH &
ROBINSON
(1925 - $1.50)

TYPICAL 1-TUBE "BABY" DETECTORS, '22

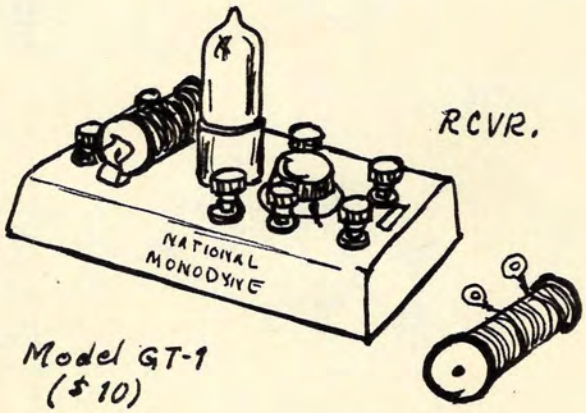




RENMAR "Babydyne"

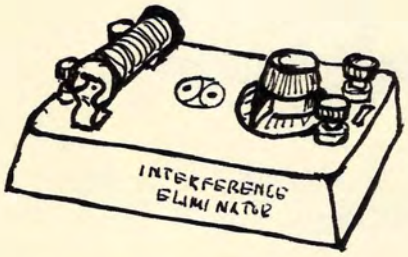


Model A
($8.50)

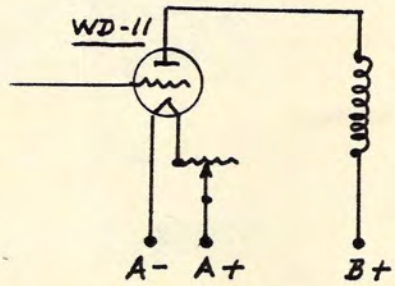


Model GT-1
($10)

NATIONAL UNITS



($7.52)



COIL WINDING DATA FOR BC BANDS

TABLE OF TURNS FOR RF

Form Diameter	Wire Size	Turns Per Inch	.0005 Condenser	.00035 Condenser
1.5" Ø	32	60	76	100
1.75"	30	54	66	88
2"	28	47	61	78
2.25"	28	47	53	68
2.5"	26	41	50	65
2.75"	26	41	44	58
3"	24	34	43	57
3.25"	22	29	43	56
3.5" Ø	20	23	43	56

Coils will cover STD BC bands only - i.e., 550-1500 KC.

Wire insulation is DCC in all instances.

.0005 Condenser requires inductance of 167.1 mH.

.00035 Condenser requires inductance of 239 mH.

Coils are for tuned circuits only; PRI and TICKLER data depend on type of tube used with variable.

Fine wire - e.g. Litz - may be used on any PRI, connected to the Plate circuit, provided PRI is NOT tune. If so, SEC should be fine wire.

If coil follows a screen-grid tube, PRI should have a larger number of turns.

If PRI is connected to the ANT circuit, fine wire should NOT be used.

TICKLERS may have one-third to two-thirds the number of truns of the SEC. This applies also for the Plate coil in an oscillator circuit.

SHORT-WAVE COIL WINDING DATA; Sht. 1

COIL WINDING DATA FOR 15 to 200 METERS:

Coil Form = 1.250" Ø.

Grid	Plate	Range	Gauge
4T	4T	15-24M	#18
10T	19T	24-40M	#18/#32
20T	10T	40-69M	#18/#32
33T	15T	69-118M	#24/#32
60T	32T	118-200M	#32

Begin winding at top of form and connect beginning to GRID lug. Turn prescribed number of turns and terminate at "F" lug. Wind Plate coil in same direction, adjoining SEC, beginning where winding ends. Connect beginning of Plate winding to "P" lug. Other Plate connexion goes to F+. Use a 4-prong UX base as a form.

* * *

COIL WINDING DATA FOR 14 to 30 METERS:

Coil Form = 1.5" Ø.

	PRI	SEC	Gauge	Length	Turns Per Inch
1.	4T	-	#30DSC	-	-
	-	7T	20 "	1.167"	12
2.	4T	-	30 "	-	-
		12T	20 "	1.0"	12

COIL WINDING DATA FOR 28 to 60 METERS:

Coil Form = 1.5" Ø.

	PRI	SEC	Gauge	Length	T.P.I.
1.	4T	-	#30DSC	-	-
	-	14T	20 "	1.67"	12
2.	5T	-	#30DSC	-	-
	-	24T	20 "	1.0"	24

COIL WINDING DATA FOR SW CONVERTERS:

Coil Form - 1.250" Ø.

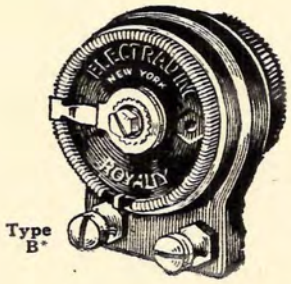
	RF	OSC	TICKLER
PRI	6T	36T	5T
SEC	39T	16T	-
PRI	3T	12.5T	2T
SEC	16T	5T	-

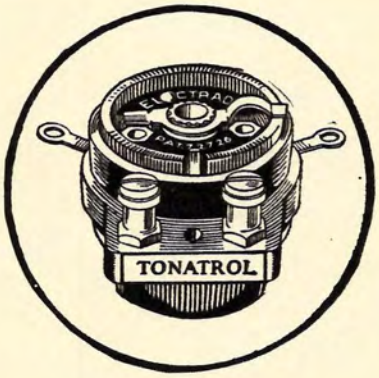
SHORT-WAVE COIL WINDING DATA; Sht. 2

	RF	OSC	TICKLER
PRI	2T	6.25T	1T
SEC	8T	3T	-
PRI	1T	4T	1T
SEC	4T	2T	-

All coils wound with #24 enamelled wire.
RF OUTPUT COIL wound on a 1" Ø form with #32 enamelled wire, number of turns to suit - that is, cut-&-try.

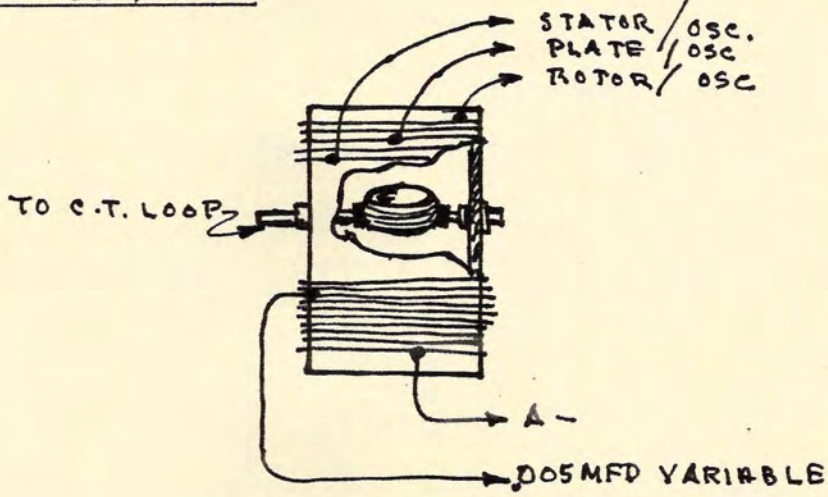
* * *





ARISTOCRATIC CONTROLS OF 1926

GHIRARDI'S COUPLER:



COMMERCIAL COIL DATA, Sht. 1

NA-ALD
ALDEN PLUG-IN COILS:

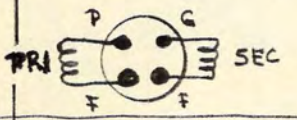
		SEC. No. of Turns	Pitch	PRIMARY
1.	BLUE - 10-20 M.	4 3/4	6, #22 DSC	4 T, #31 DSC
2.	RED - 20-40 M.	10 3/4	12, "	6 T, "
3.	YELLOW - 40-80 M.	22 3/4	16, "	7 T, "
4.	GREEN - 80-200 M.	51 3/4	40, "	15 T, "
5.	WHITE - 200-350 M.	68 3/4	C.W., #28 DSC	28 T, #36
6.	ORANGE - 350-500 M.	131 3/4	B.W., #32	32 T, " DSC

C.W. = Close Wound. B.W. = Bank-Wound, 2 Layers.

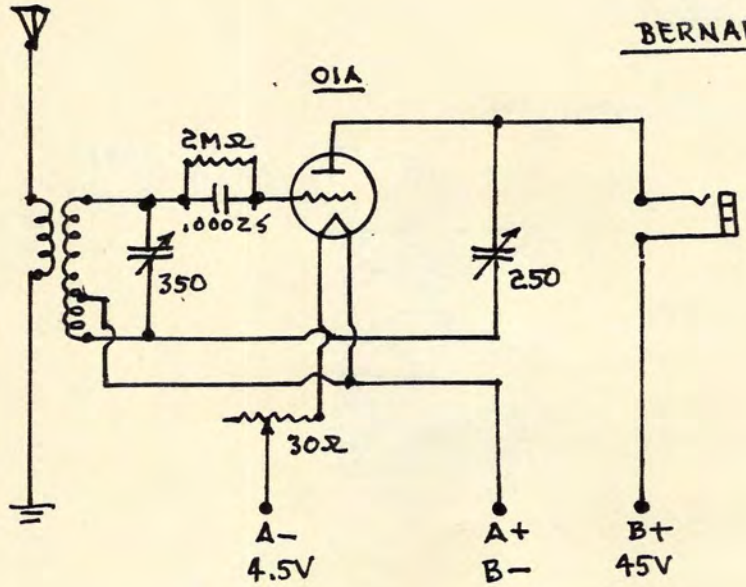
OCTO-COILS:

	SEC. No. of Turns	Pitch	PRI
1) 16-30 Meters	5 T, #12 Enam.	5 T per Inch	6 T, C.W., #24 Enam
2) 29-58 Meters	12 T, #14 "	12 T per 1 9/16"	8 T, " , "
3) 54-105 Meters	26 T, #14 "	26 T, per 2 1/16"	12 T, " , "
4) 100-200 Meters	45 T, #24 "	45 T, per 1 3/8"	20 T, " , "

SPACING BETWEEN WINDINGS: (1) 5/16"; (2) 3/16"; (3) 3/32"; (4) 1/8"



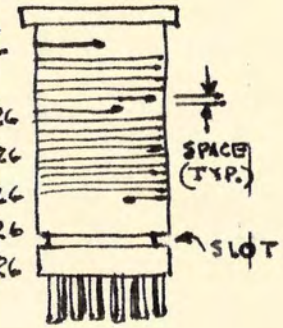
BERNARD 1-TUBE DX SET; 1925



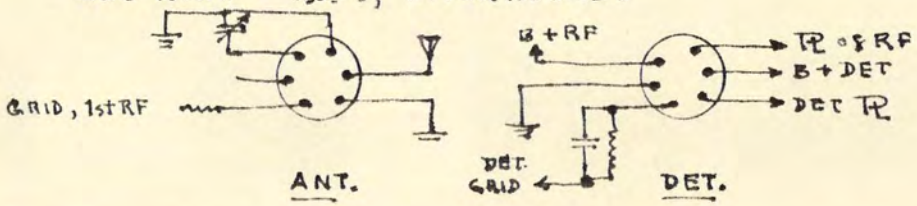
PANEL = 7"x12"

NATIONAL PLUG-IN COILS; (Antenna & Detector):

	PRI	SEC	WIRE	SPACE	SLOT
9-15 Meters, #60	~		~	~	~
13.5-25 Meters, 61	5¾T, #24	6¼T, #14		7/32"	2T, #26
23-41 Meters, 62	9¾T, #24	11¾T, #18		5/32"	2T, #26
40-70 Meters, 63	12¾, #26	13¾T, #18		3/32"	2T, #26
65-115 Meters, 64	21T, #26	34¾T, #24		1/16"	3T, #26
115-200 Meters, 65	38T, "	63¾T, #24		1/32"	5T, #26



BOTH COILS ARE IDENTICAL IN CONSTRUCTION.
ALL WIRE = S.S.C.; INTERWOOND.



NOTE:
3 PRONGS ALONG RH ARC ARE CLOSE TOGETHER, BOTH.

INSULINE CORP. of AM. COILS: (2"Ø)

	RF COIL	DET. COIL	TICKLER (On DET. Coil)
17-28 Meters	6T	4S; 1P	4T
27-45 "	11T	8T/S; 3T/P	6T
40-80 "	19T	18T/S; 4T/P	8T
75-150 "	34T	30T/S; 10T/P	15T
145-300 Meters	54T	54T/S; 15T/P	18T
295-600 "	107T	139T/S; 30T/P	50T

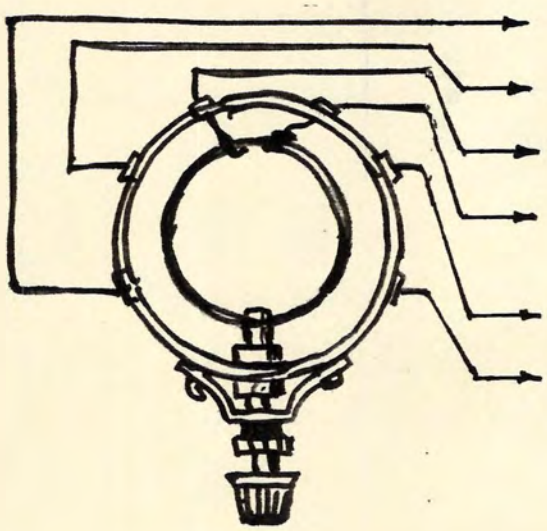
T = Turns
S = SEC
P = PRI

ANT. COIL = $1\frac{15}{16}$"Ø, 10T

COMMERCIAL COIL DATA, Sht. 2

TWO COMMERCIAL TUNER CONNEXIONS(Typ.)

CITIZEN's JR.:



To "P" on 1st RF tube socket.

To B+ 90V post.

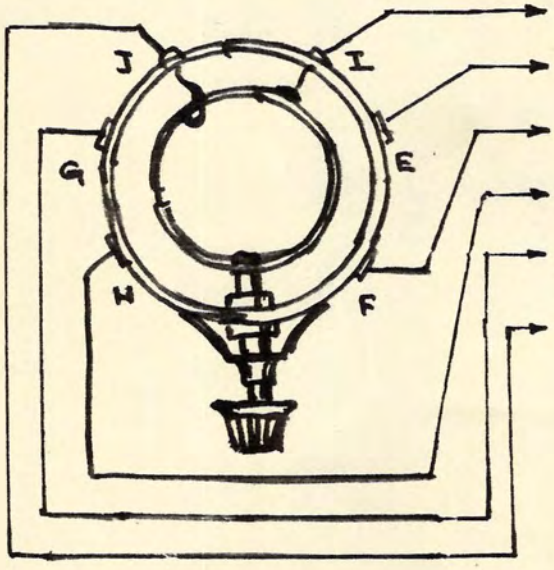
To "P" on DET tube socket.

To .0001 fixed condenser & "P" on 1st AF transformer.

To FIL switch (-).

To stator of 2nd variable (G/L).

BRUNO #99 COIL:



To 1st RF transformer plate.

To 1st RF tube plate.

To B+ 67.5V post.

To variable & A+.

To variable & grid of 2nd RF tube.

To plate of 2nd RF tube.

SILVER-MARSHALL COIL DATA & RANGES

Series #131

T = 17.4 - 32 Meters
U = 31 - 58 Meters
V = 56 - 110 Meters
W = 105 - 204 Meters
X = 190 - 360 Meters
Y = 345 - 650 Meters

Series #110

A = 190-500 Meters
B = 90 - 220 Meters
C = 50 - 110 Meters
E = 500 - 1800 Meters

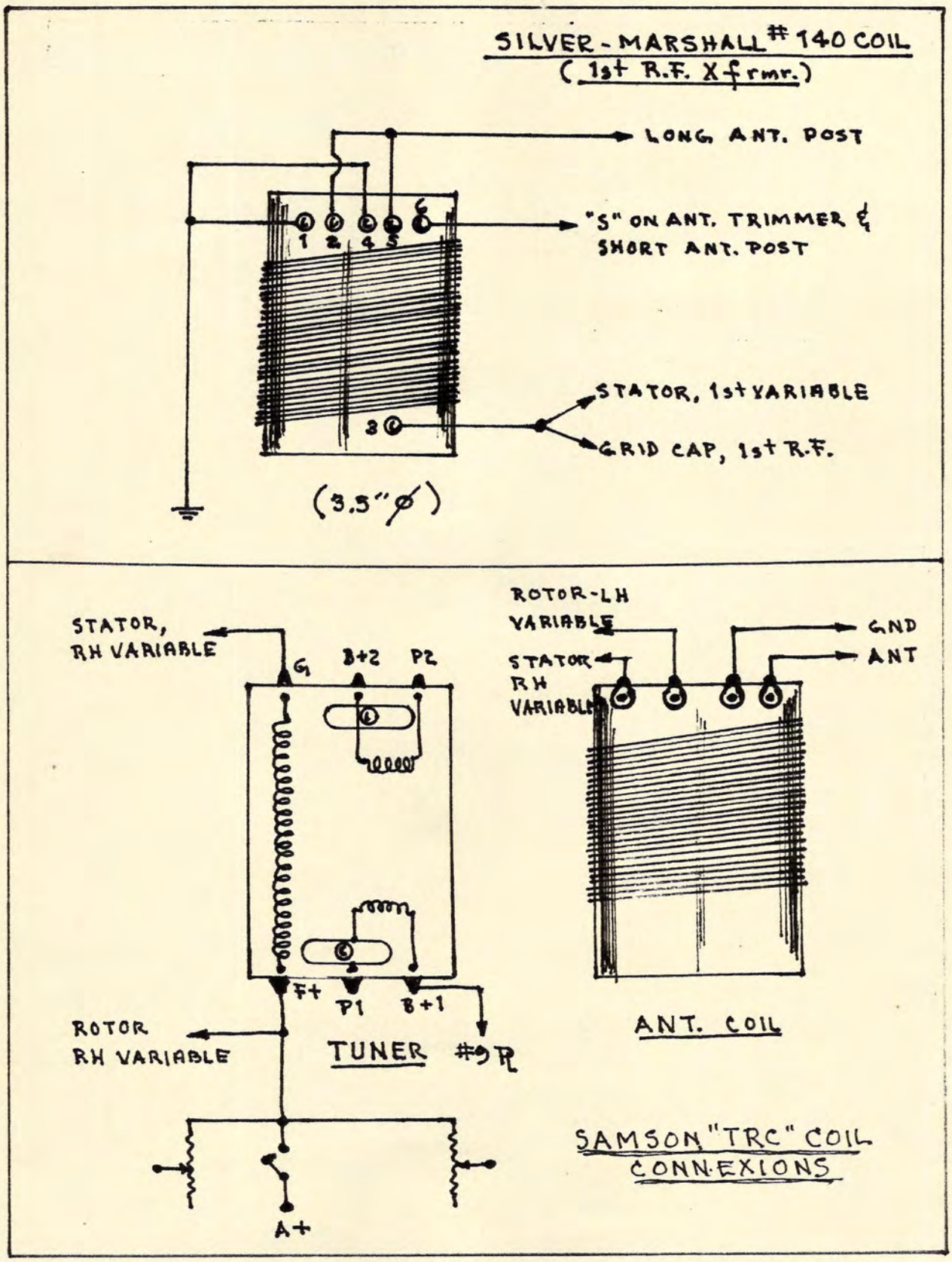
Coil Winding Data:

1. 6.9T, #22 Enam.; 5.5T.#34 DCC.
2. 13.5T, #22 Enam.; 5.5T; #34 DCC.
3. 25.5T, #22 Enam.; 9.5T; #34 DCC.
4. 49.5T, #24 DCC; 15.5T, DCC #34.

Series #140

(These were universal coils, with one coil having windings to connect in series with ANT.)

TECHNICAL TIPS SHEET



COIL WINDING DATA FOR S.L.F. VARIABLES

T = Turns Ø = Diameter DCC = Double Cotton Covered Wire

CONDENSER	WIRE	TICKER	SECONDARY	FORM
250 MMFD	#20 DCC	40T	-	1.¼"Ø
	"	-	128T	2½" Ø
	"	30T	-	2.75"
	"	-	70T	3.75"
	"	35T	-	2.0"
	"	-	80T	3"Ø
375 MMFD	#20 DCC	50T	-	1¼" Ø
350 MMFD	"	-	93T	2½"
	"	45T	-	2" Ø
	"	-	70T	3" Ø
	"	30T	-	2.75"
	"	-	53T	3.75" Ø
(TICKLER WINDINGS FOR THE FOLLOWING ARE THE SAME AS ABOVE.)				
1. 500 MMFD	#20 DCC	-	70T	2½" Ø
		-	46T	3" Ø
		-	38T	3.75" Ø
2. 250 MMFD	#22 DCC	-	110T	2½"
		-	70T	3.75"
3. 375 MMFD	"	-	88T	2½"
		-	60T	3"
		-	46T	3.75"
4. 500 MMFD	"	-	66T	2½"
		-	45T	3"
		-	35T	3.75" Ø
5. 250 MMFD	#24 DCC	-	102T	2½"
		-	65T	3"
		-	55T	3.75"
6. 375 MMFD	"	-	78T	2½"
		-	56T	3"
		-	42T	3.75"
7. 500 MMFD	#24 DCC	-	62T	2½"
		-	44T	3"
		-	32T	3.75" Ø

When single layer cannot be made of TICKLER winding, the haphazard manner should be employed.

NOTE: The simplest way to use these data is to find the coil form diameter you have on hand, then wind for variable.

HOME-MADE COIL FORMS, 1925

BASKET-WEAVE FORM #1:

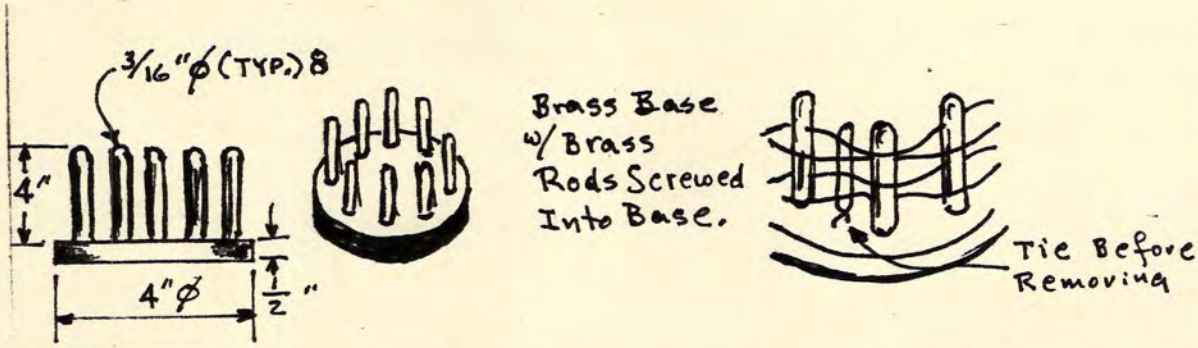
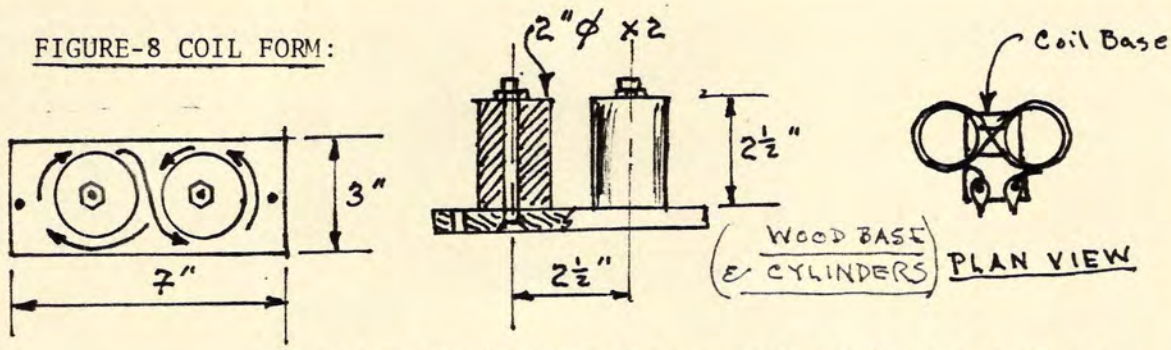
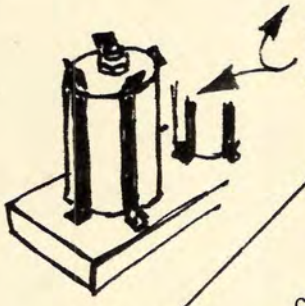


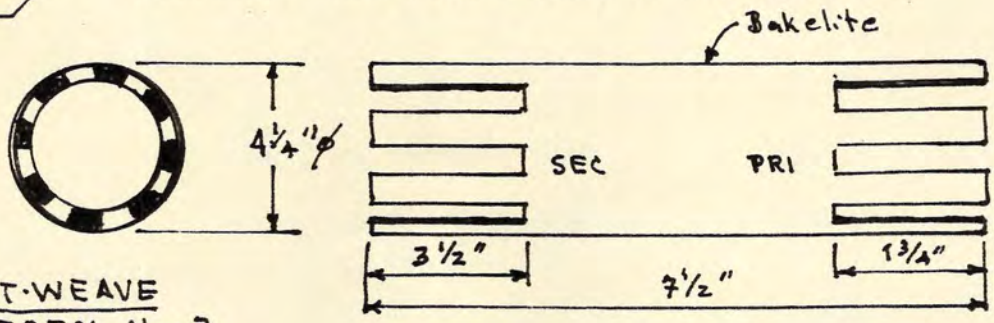
FIGURE-8 COIL FORM:





Place surgical plaster or glue-strips as shown to hold wire. When completed, fold over strip ends to make a free-standing coil.

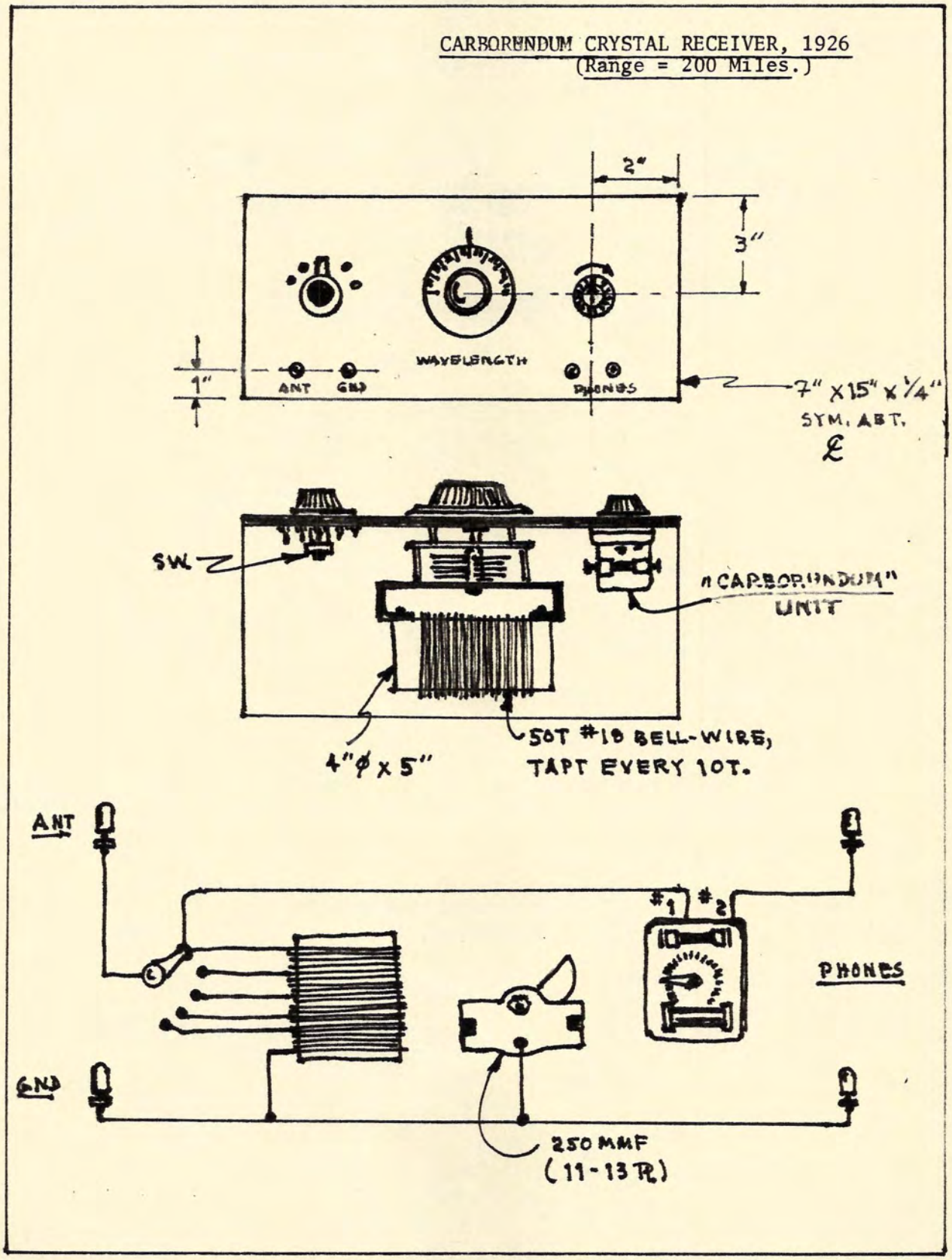
Tube divided around circumferance into 22 equal divisions. Cut out 11 of these divisions; de-burr edges. PRI = #18 DCC tapt @ 8,20,38,60T. SEC = 90T #28 DSC tapt @ 15, 30, 55, 90. Start counting for taps from ends of PRI & SEC closest to each other. Slot width = width of hacksaw blade.



BASKET-WEAVE COIL FORM No. 2 (R-9-'23)

BASKET-WEAVE FORM #2, 1923

CARBORUNDUM CRYSTAL RECEIVER, 1926
(Range = 200 Miles.)



SOLE SOURCE DATA

While most all of the early schematics gave part numbers or model designation, reference to the full details of such numbers is not readily available, or simply non-existent. In this sexion I have compiled a miscellania of incidental data, insignificant in themselves, but critically important when you need them. You will not find such data in Rider's or Sams or Gernsback's Encyclopedia, but you will find them in these SketchBooks. For example:

ELKAY "EQUALIZER" FILAMENT CONTROL TYPES:

Type:	Used With:
0	Mu-6, Mu-20
2	01A (2), 12A
4	01A
25	99 (2), 120
35	99 (with series rheostat)
50	99

RESISTANCE RHEOSTATS FOR FILAMENTS:

01A Tubes, No.	1	2	3	4	5	6	7	8
Rheostat/Ohms	20	10	6	6	3	3	2	2

NOTE: One 200 tube = (4) 01As.
One 200A " = (1) 01A.
One 12/71 " = (2) 01As.

99 Type Tubes	1	2	3	4	5	6	7	8
Rheostat/Ohms	75	50	30	20	20	20	10	10

NOTE: one 120 tube = (2) 99s.
When schematic calls for values other than the above, disregard the schematic values.
Some early circuits used 9 and 10 99s; a 6-ohm pot.

CE-CO LETTERED TUBE EQUIVALENTS:

A/AX = 01A, Amplifier/Detector
B/BX = 99, Amplifier/Detector
B-C = Amplifier/Detector
D-C = Amplifier/Detector/Power Amplifier
D-G = Raytheon "B"; Gaseous Rectifier
E = 20, Power Output
F = 12A, Power Output
G = Hi-Mu 20, Hi-Mu 40
H = 00A, Detector

J/J71/J71A = 71A, power Output
K = RF Amplifier

* * *

ODD TUBE DESIGNATIONS EQUIVALENT TYPES:

80 = 13-B, D1, RE-1
81 = RE-2, 16-B, D½
50 = SO-2, 585/586
1-V = 6Z4, AD, 6Z3, KR-1
82 = AF
83 = AG
24A = 22AC
27 = DE-1
2A5 = KR25
47 = PZ (Arcturus)

Tube data cross-references for military designations, British and European designations seem to be readily available, so are not repeated here. The above listing were of moment to me, and I could not find them all in one place.

* * *

SAMSON RFC NUMBERS & VALUES:

#85 = 85 mH
125 = 250 mH
500 = 500 mH
3 = 3.5 H (AF)

* * *

OXIDE FILAMENT TUBES THAT CAN BE REJUVENTAED:

12A 71A 24 24A 26 27 30 31
32 45 50 51

Refer to Volume VI for detailed procedures of how to rejuvenate the early tubes. Schematics for constructing your own tube-rejuvenators, as well as original operating instructions for commercially produced rejuvenators will also be found there.

* * *

ARCTURUS "CORONET" METAL TUBE SERIES:

24, 27, 35/51, 55, 56, 57, 58, 75, 77, 78, 80, 82, 2A6.

One 200W light bulb = 60.5 ohms resistance.

* * *

TO DETERMINE UNKNOWN VARIABLE CONDENSER VALUES:

$$C = \frac{2235 \times A \times k \times (N-1)}{10^{10} \times t}$$

where: C = capacitance in MFD
A = area of one side of one plate, in square inches
k = dialectic constant
t = plate separation in inches
N = total number of plates.

* * *

"AMPERITE" TYPES & APPLICATIONS:

Type:	Used With Tubes:
AMP 1A	UX99, 01A
6V-199	V99 (RF)
622	22 Screen-Grid
12	12/12A/71
5-A-5	AC Line Ballast
13-20	AC Voltage Regulator

* * *

C-BATTERY VOLTAGE TABLE:

Number of Tubes:	C-Voltage							
	1	2	3	4	5	6	7	8
01A	-	-	15	16	15	12	10	9
99	-	-	-	-	-	-	-	21
(2) 01A + 12	-	19	16	15	13	12	10	9
(2) 99 + 20	-	-	-	-	-	-	21	18
12	19	16	13	12	12	9	1.5	6
20	-	-	21	15	12	10	7.5	15

* * *

TECHNICAL DATA SHEET

INDUCTANCE OF HONEYCOMB COILS

Turns:	Inductance (mH):
25	.04
35	.07
50	.15
75	.325
100	.550
150	1.3
200	2.3
250	3.7
300	5.4
400	9.6
500	15.5
600	21.5
750	34.0
1000	62.0
1250	103.0
1500	155.0

CRITICAL PILOT LAMPS

We have all grown used to pilot lamps being more or less standardised, but in early sets incorporating pilots, they could be critical, especially if you were using a seperate "A" battery. When the pilot lamp is in series or series-parallel arrangement with the tube filament, it is extremely important that a replacement bulb be exactly the same. This is also true of early tuning meters. Otherwise, a serious drain of "A" voltage can result.

A NOTE ON "ROGERS" TUBES

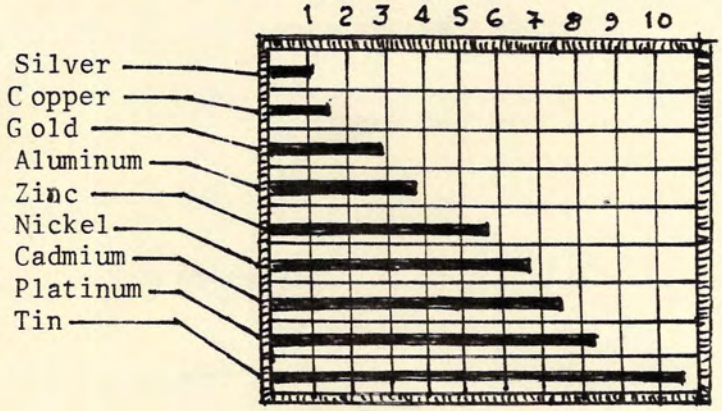
The ROGERS tube was manufactured in Canada by Canadian Radio Corporation, Ltd, under license from RCA. Most did not have an equivalent or a substitute in U.S. tube types. A single letter was usually employed after the type designation, either an "S" or an "M". The "S" indicated a spray-shielded tube, and the designation was used briefly here by the RME.

CAPACITY		REACTANCE		HENRIES
.085 MFD	=	30,920 ohms	=	82.3
.07		34.6K		100
.015		173K		2
.70		3,710		10
.55		4.725		12.5
.50		5,200		14
.45		5,775		15.5
.35		7,424		20
.22		11,800		31.8
.16		16,250		43.7
.14		18,500		50
.10		26,000		70
1.00		2,600		7
1.40		1,855		5
2.00		1,300		3.5
2.80		928		2.5
7.00		371		1
60.00		3,710		10
.20		13,000		35

RELATIVE RESISTIVITY OF VARIOUS METALS OF EQUAL SIZE:

Copper is more efficient than aluminum alloys, and iron is the worst form of shielding.

Panels with copper-screening embedded are inefficient.



• • •
• • •
•

NEUTRODYNE NOTES:

1. Do not force loud signals via too much B+. 67.5V was deemed normal, and never more than 90V.
2. Variables were usually 17 plates.
3. A variometer may be used for obtaining regeneration. This should be placed in the lead from the "P" terminal of the 3rd tube, to the PRI of the following xfrmr.
4. If howls or squeals occur, try reversing xfrmr. leads one at a time.

* * * *

RECLAIMING SULPHATED STORAGE-BATTERIES:

Dissolve ½-lb. of Potassium "Hydrate (caustic potash) in 2 quarts of distilled water. Empty battery cells. Pour in hydroxide solution to cover plates. Charge battery at a lower than normal rate.

After 24 hours discharge battery through a resistance. Charge battery again in a normal fashion. DO NOT DISCHARGE. Empty battery and fill cells with distilled water and let sit for several hours. Empty battery. Fill with regular battery acid, and charge normally.

* * *

A SHORT-WAVE TUNING METER:

A 0-5 mA meter can be used as a SW tuning meter by connecting it in series with plate feed to an RF or IF tube; or in the common screen lead to several tuner tubes; or in any circuit where the steady value of current does not exceed 2 to 3 mA.

* * *

COIL COMPUTATIONS #3:

$$L = \frac{0.03948\ a^2\ n^2\ k}{b}$$

where: L = inductance required
a = radius of coil form
n = number of turns
b = length of winding
k = constant (NBS)

* * *

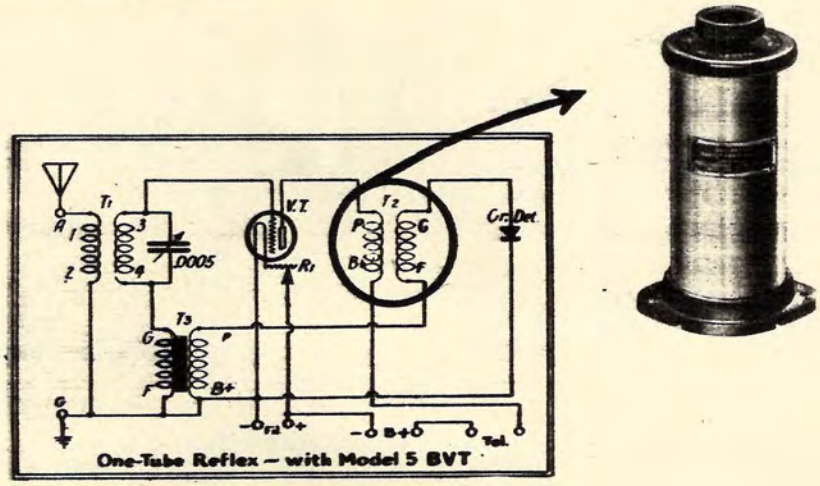
IMPEDANCE-COUPLED AMPLIFIERS & B-ELIMINATORS:

This is not a good combination. If you want to use such a combination, insert an AF choke in each B+ lead from the eliminator; add a condenser of 1 oe 2 MFD to by-pass each choke coil - i.e., between B- and each of the positive leads. This arrangement will isolate the eliminator from the receiver.

WESTERN ELECTRIC LOUD SPEAKER NOTES:

Type 518W had a normal impedance of about 25 ohms at 1000 cycles. The SEC of the output transformer in the W.E. P-P amplifier was designed to work directly into the 518W receiver. The impedance is below 10K ohms, and no other transformer or compensating device is needed. You cannot work the 518W directly into the output of a vacuum tube without a step-down transformer - which W.E. provided in their 10-D speaker. The 518W receiver w,s intended to work with the W.E. 10-A amplifier, which had the same output transformer as the 10-D speaker. On the 10-D speaker the output transformer has a 2k-ohm SEC and a PRI impedance of 15K-ohms. The W.E. Type 540 AW speaker at 1000 cycles had an impedance of around 10K-ohms, but at 100 cycles it dropt to 2K-ohms. The 548 AW was the same as the 540 AW unit.

BOONTON REFLEX, 1924:



* If unstable, reverse P and B+

TECHNICAL TIPS SHEET

VINTAGE TUBES SUBSTITUTION LISTINGS

00A	01A/40
01A	00A/00AA/01B/40
0A2	0B2(P)
0A3	VR75
0B3	VR90
0Z4	6X5/7Y4/84 *
1A3	1R4/1294 *
1B4	1A4/1E5/32/34
1D5	1A4/1B4/32/34.951 *
1E5	1D5(P)
1S5	1AF5/1U5 *
1T4	1U4
1L6	1U6 *
1U5	1S5 *
2A3	45/
2A5	47/59/1618 *
2A6	55
2C21	6SN7 *
2V3	2X2/879(P)
3V4	3C5
5U4	5AX4/4AZ4/5R4/80/83 83V/5Z4/5Y3/1275/5Z3/5T4
5Y3	5Y4/5X4/80 *
5Z3	5U4/5X3
10	10Y/RK10/210/310
12A	71A
15	1A4/1B4/1E5.32/34
19	1J6 *
20	X99 *
24A	35/51; 57/58 *
27	56/485
30	1H4 *
31	30
33	1F4/950
34	1A4/1B4/32.951
35/51	24A
36	6C6/6D6/39-44/77/78
37	76
38	41/42
39/44	6D6/78/6K7/6SK7/7A7/36 01A/12A *
56S	27/56
57	58
59	47/1619 *
71A	482/483 *
75	85/6B6/6Q7/6R7/6SQ7/6V7/7B6/
76	6C5/7A4/XXL * 6BK6
77	6J7/6SJ7/1221
78	6D6/6K7/6SK7/7A7*/39-44
84	7Y4 *

P = poor substitute

* = Socket change (wiring).
(Tubes for which there are no substitutes are not listed.)

41*	6A4/6F6.6L6.6U6/6V6/6K6 7A5/7B5/38/42/89
42	(same as 41)
43	25A-B-CL6/5824 *
45	2A3
46	47
47	2A5/59/1619 *
50	10
53	5608
55	2A6
56	27/485
56A5	37/76

SOLDERING OLD SQUARE BUSS-BAR

Occasionally we all come by a packet of original square buss-bar, usually "Celesite", sometimes colour-coded, most often simply superfically tinned. These are happy finds and some of us like to use as much original parts as we can, but with the square (or round) buss-bar from the Twenties, there are problems.

The art of metallurgy has advanced mightily since then and modern techniques and solder aren't the same. When you do come by some old buss-bar, you should consider the following:

1. The wire will usually be discoloured from the passage of time. It can be polished with steel-wool or "Semichrome" paste, but some discolouration will remain. This is due to the imperfect tinning process of the times. The use of the original shellacked black "speghetti" would enhance it.

2. The composition of buss-bar available in the Twenties differed considerably from similar wire today. The molecular structure was uneven and modern electric soldering-irons, such as are the vogue among those who work with PC boards, won't touch the old wire. You will need a very hot iron, such as the old "American Beauty" iron that was heated by a blow-torch or over a gas jet (but without ever allowing it to become red).

3. Again, because of the early compositions, as well as ageing, you will find that the buss-bar is much more brittle than its modern counterpart. It will not take a sharp 90° bend, for example, without producing tiny cracks at the bend. A mellow bend can be made, using round-nose pliers. It was also the fashion to form hold-down lugs, as loops, at the termination of buss-bar. This is not advised, as you run the risk of breakage.

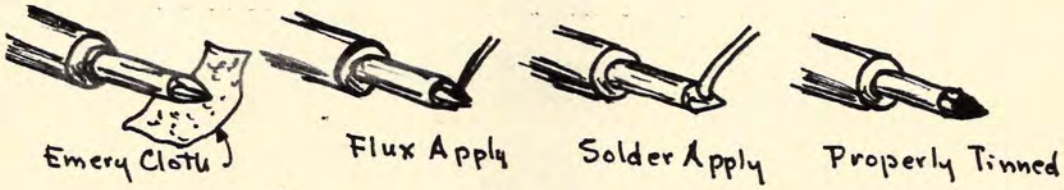
The sketches which follow show graphically how the old-timers acheived their neat, clean soldered joints. Modern solder is also better, of course, with Ersin's 60/40 preferred, but you should remember that modern solder will flow faster than the old solder, while the old square buss-bar is just beginning to heat-up. One technique is to heat the buss-bar first, then apply the solder, a technique that has not been improved upon.

In the early days, if you're old enough to remember, flux came in little tin cans, or in a tube. Like Sears-Roebuck shoes, such fluxes were good-better-best. Some were quite harmful, due to an excessive amount of hydrochloric acid, zinc and ammonia. What made such fluxes

harmful was the chloride residuals, which were both corrosive and conductive of electrical energy. This caused leakages and losses of signal strength, as well as volume and distance in many an early circuit.

Then, too, some fluxes developed their greatest capacity as odixe solvents at high temperatures; some at low temperatures. Contrary to popular belief, there is no such things as a "universal" soldering iron, modern electrical gadgets to the contrary not-with-standing. The old "American Beauty" iron remains the best tool, if properly used.

Modern rosin-core solders, such as Ersin, are neither corrosive nor conductive. However, any attempt to use rosin-core solder on nickel-plated joints or parts will result in failure. Such parts must be filed and cleaned. This is due to the fact that the abietic acid - the oxide solvent of rosin - has a negligible capacity for nickel oxide. Rosin displays its greatest flux activity on metal plated with tin, silver, cadmium, gold, or on unplated but clean copper, brass, and zinc.

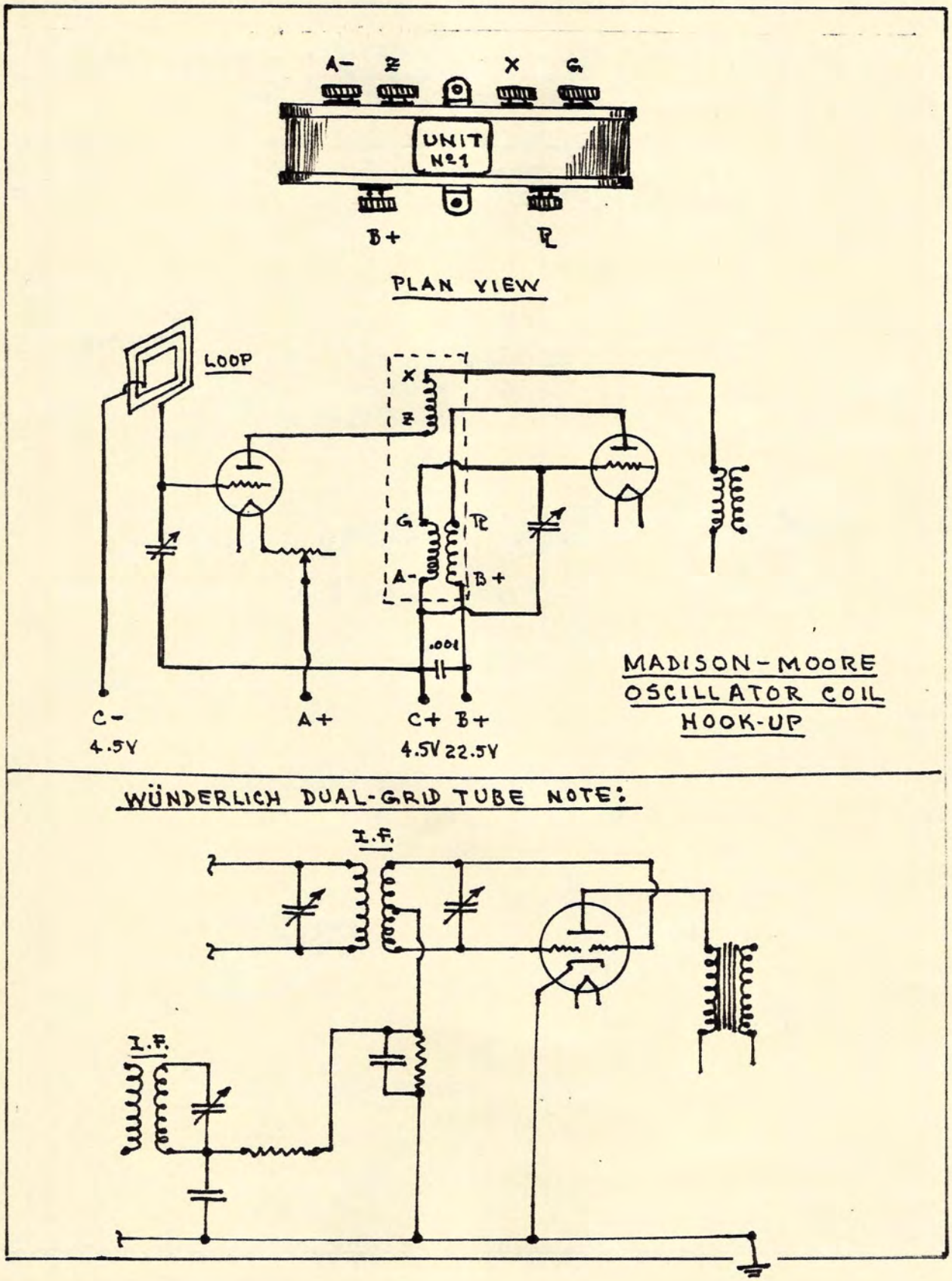


(NOTE: Application of FLUX is obviously no longer required w/ modern solder.)

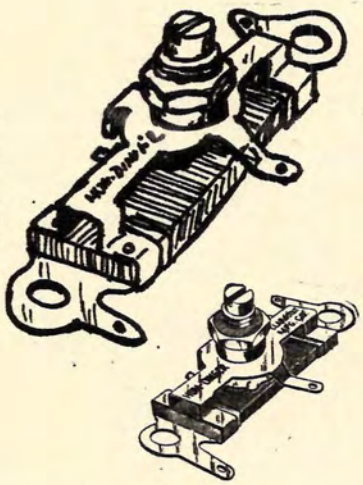
TO PREPARE YOUR SOLDERING IRON

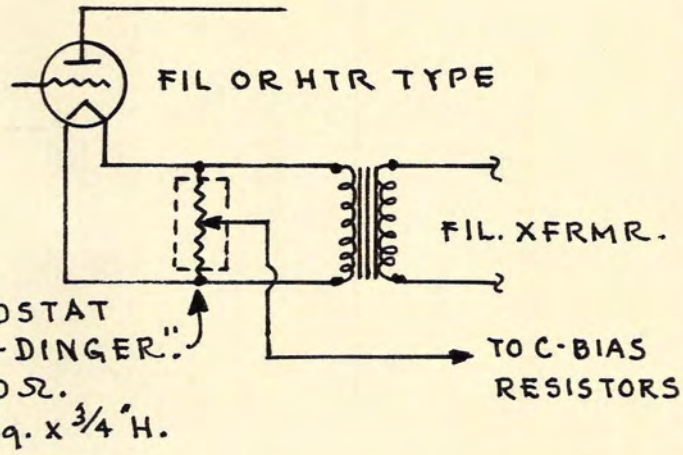
TWO WAYS TO SOLDER BUSS-BAR TO A LUG

TECHNICAL TIPS SHEET



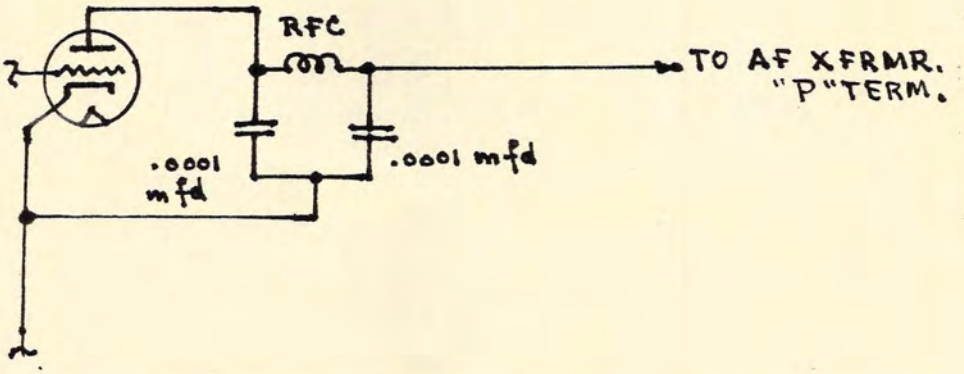
TECHNICAL TIP SHEET





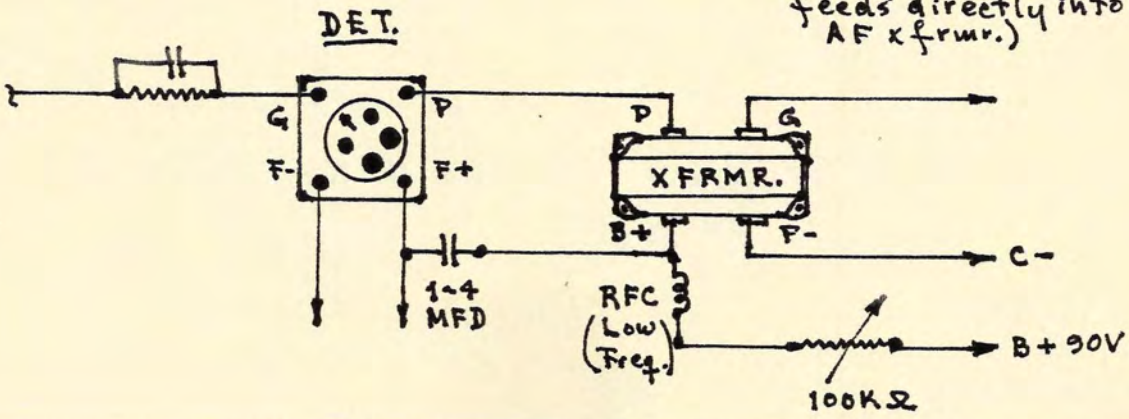
1928
CLAROSTAT
"HUM-DINGER".
6 ~ 30 Ω.
1½" Lg. x ¾" H.

IMPROVED BY-PASS CONFIGURATION:

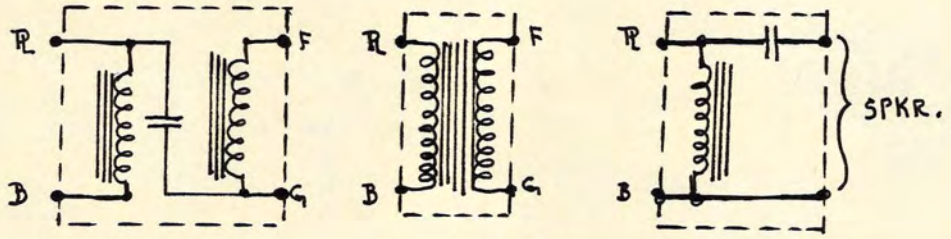


IMPROVING AF XFRMR. COUPLING:

(Only when DET feeds directly into AF xfrmr.)

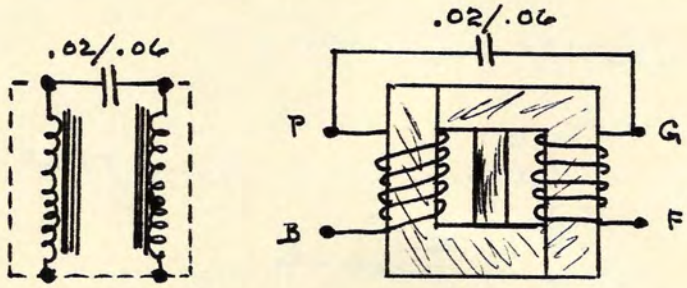


AF TRANSFORMER INTERNAL CONFIGURATIONS

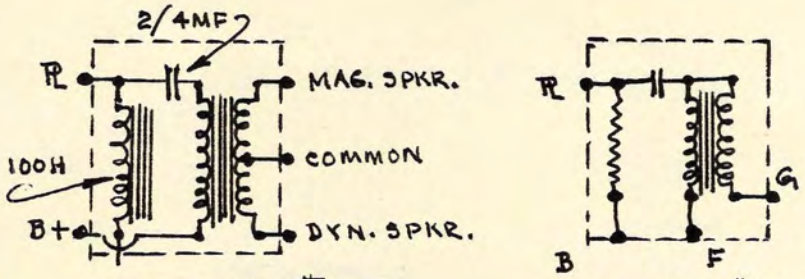


TYPE 373 TYPE 285-D TYPE 387-A

THREE GENERAL RADIO AF UNITS INTERIORS
(S-M "Auto-Former" Same As G-R 373.)



E.E. HILER DOUBLE-IMPEDANCE AF
Frequency response curve can be altered by changing cplng. cond. values.

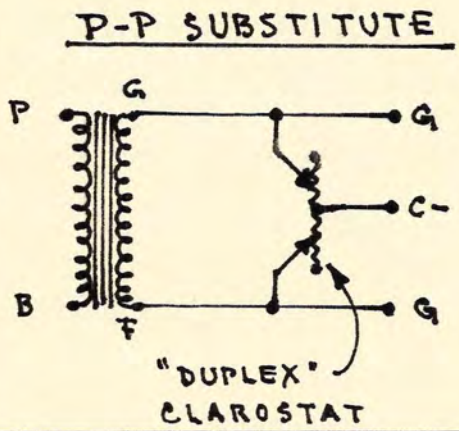


REMLER #923
"IMPEDAFORMER"
AF OUTPUT XFRMR.

REMLER #900
INPUT AF
XFRMR.

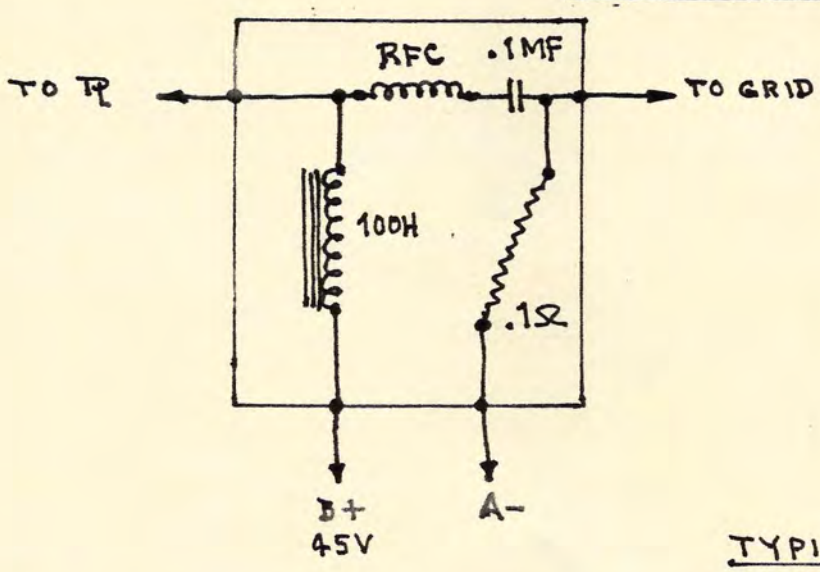
TECHNICAL TIPS SHEET

P-P SUBSTITUTE



Tube arranged in conventional P-P style, the 2 Pl's being connected to the ends of a centre-tapt choke-coil; the C.T. being connected to B+.

TYPICAL "IMPEDAFORMER" CONFIGURATION



TYPICAL IMPEDAFORMER CONFIGURATION

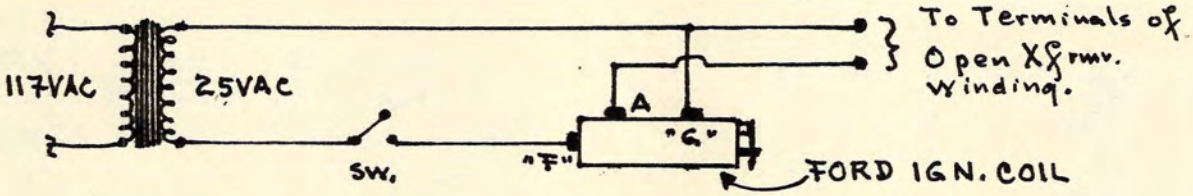
SANGAMO AF TRANSFORMER IDENTIFICATION....were identified by the placement of a half-inch coloured dot on one side. The colour of the dot told you the type of AF xfrmr. it was. You may come by a Sangamo xfrmr. with the name-plate missing, and the dot will tell you:

Type "A" for usual transformer coupled amplifier.
Type "B" input for "push-pull."
Type "C-171" output for "push-pull" (171 tube).
Type "D-210" output for "push-pull" (210 tube).
Type "E" output impedance (30 henrys).
Type "F" plate impedance (200 henrys).

Yellow Dot	=	Type A; for cascade amplification.
Light Blue	=	Input, for P-P amplification.
Dark Blue	=	P-P output for 10,12,12A tubes.
Green	=	P-P output for 71 and 71A tubes.
Red	=	Type E; output impedance; tapt for 12,71.
Orange	=	Impedance-coupled amplification; auto-xfrmr. coupled; plate impedance for DET.

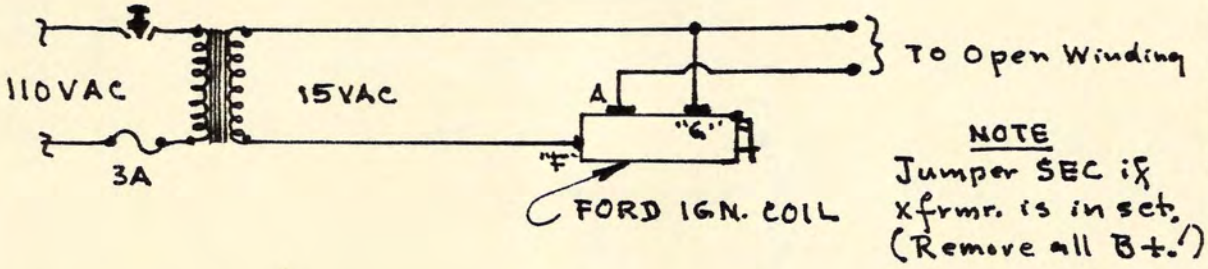
TECHNICAL TIPS SHEET

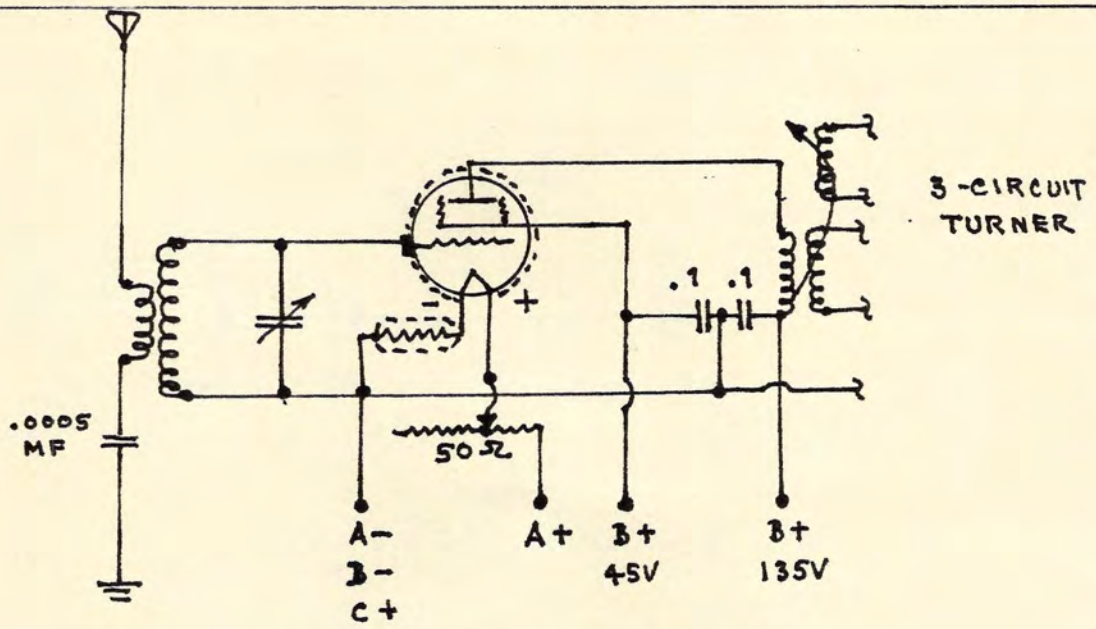
OPEN XFRMR. WINDING REPAIR #1:



Close switch for a few seconds @ a time.

OPEN XFRMR. WINDING REPAIR #2:

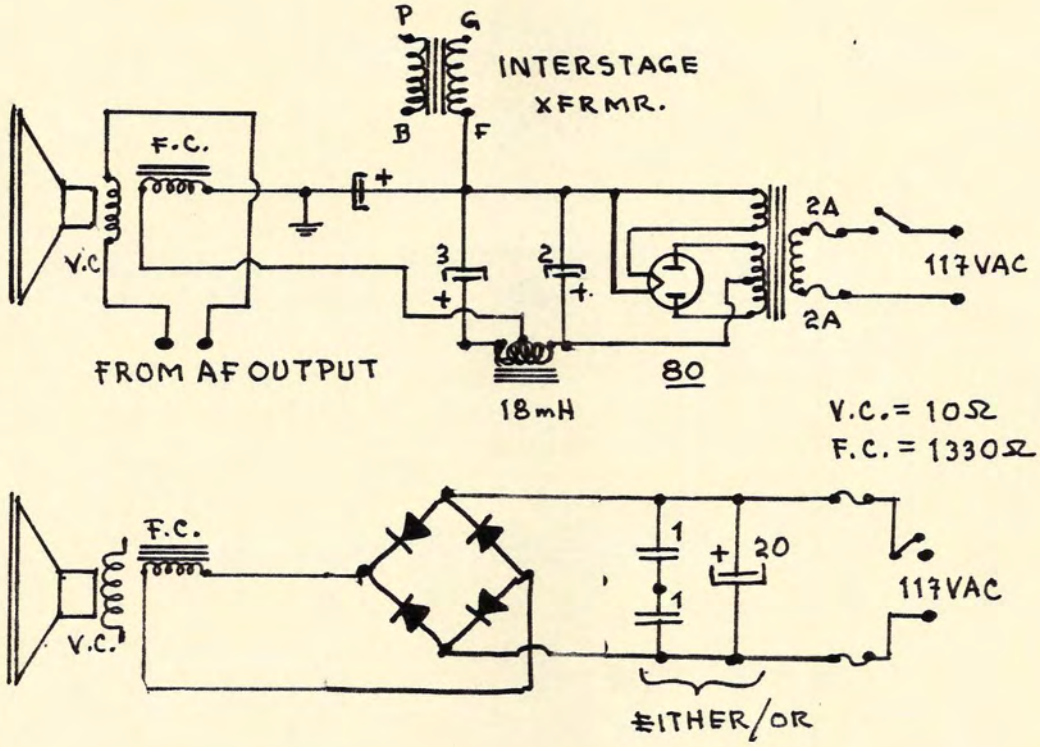




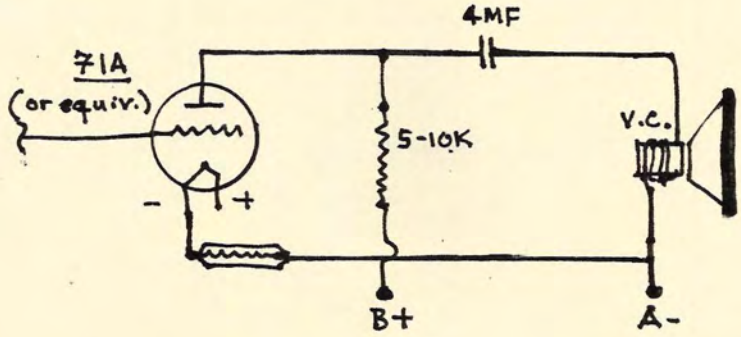
SECURING RF STABILITY w/ SCREEN-GRID TUBE

TECHNICAL TIPS SHEET

TYPICAL ELECTRO-DYNAMIC SPEAKER HOOK-UPS:

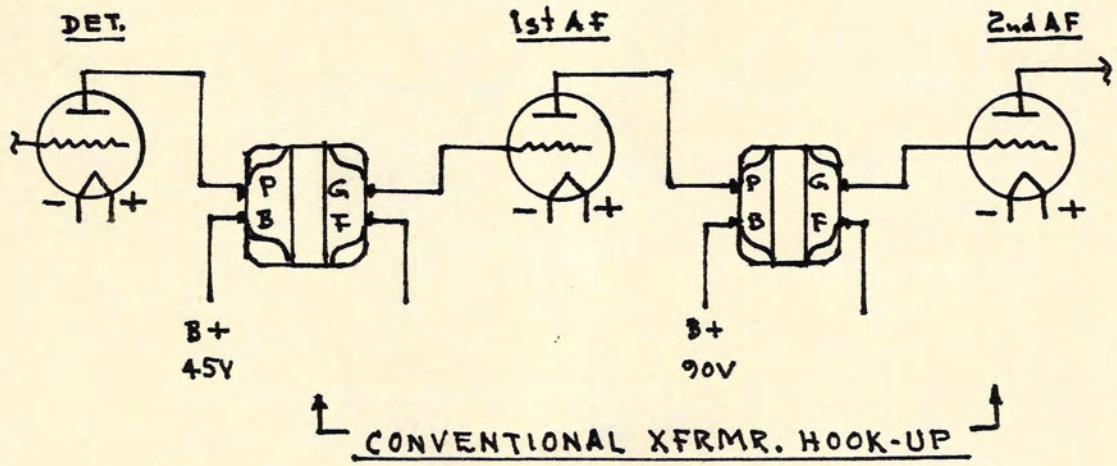


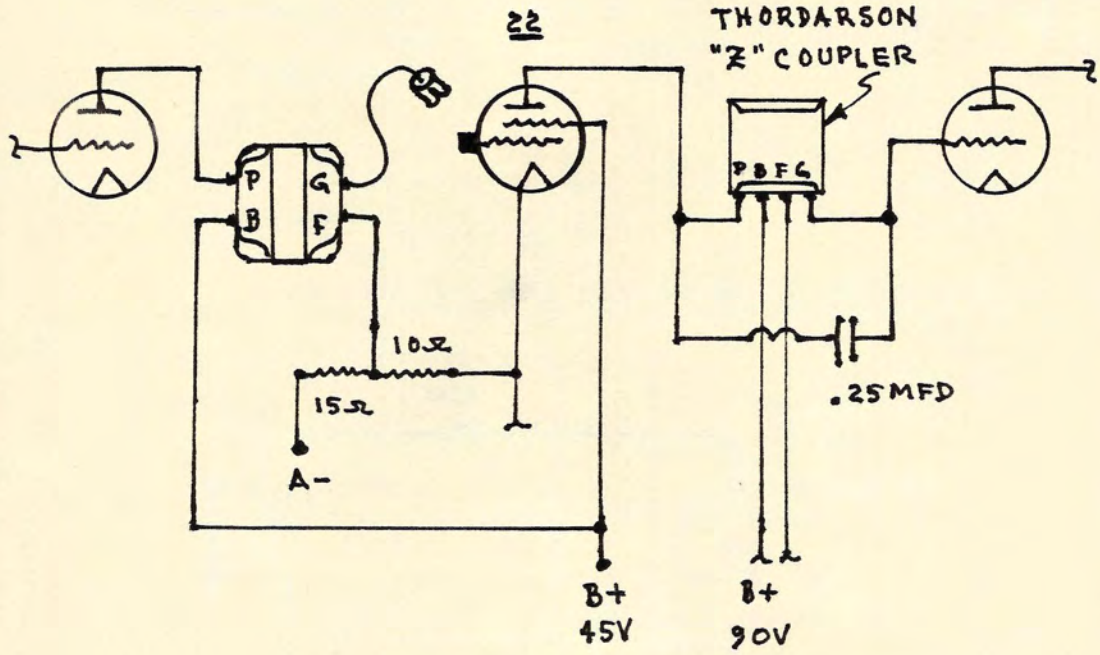
RESISTANCE-COUPLING TO A CONE (PM) SPEAKER:



TECHNICAL TIPS SHEET

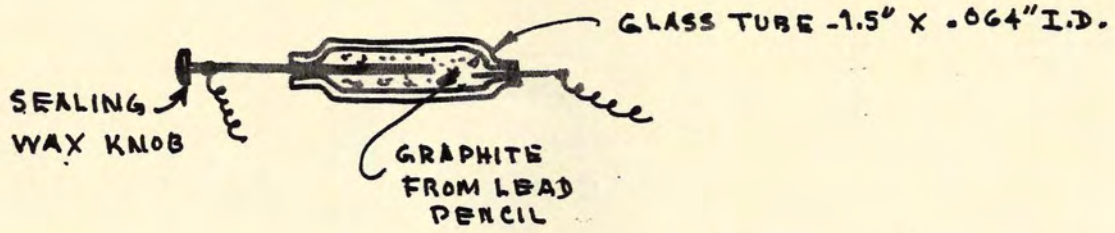
AF XFRMR. TO IMPEDANCE COUPLING:





TECHNICAL TIPS SHEET

HOME-MADE VARIABLE GRID-LEAK:



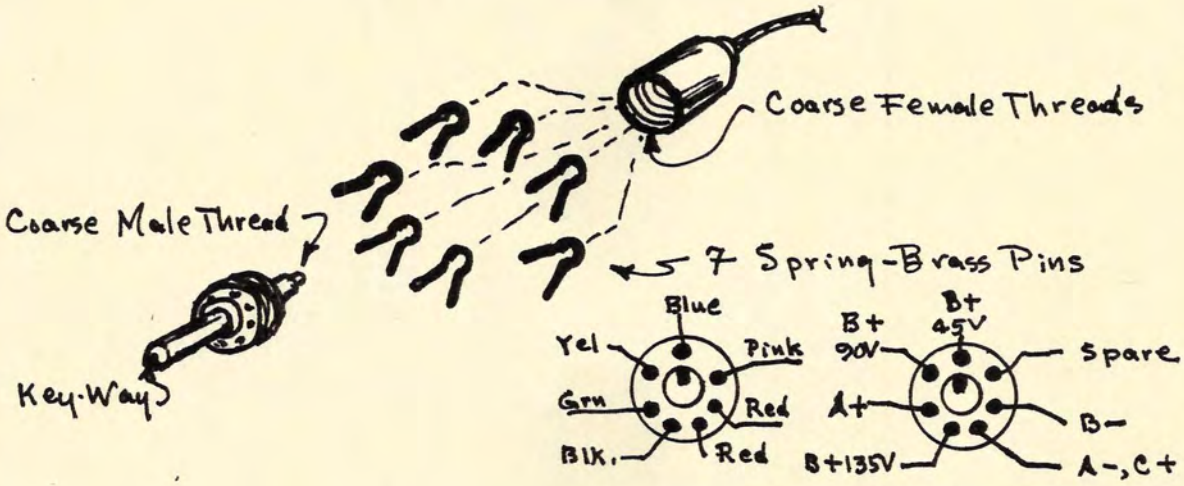
RHEOSTAT & POTENTIOMETER IDENTIFICATION:

"M" TYPE
4 W
Contact Arm
Insulated

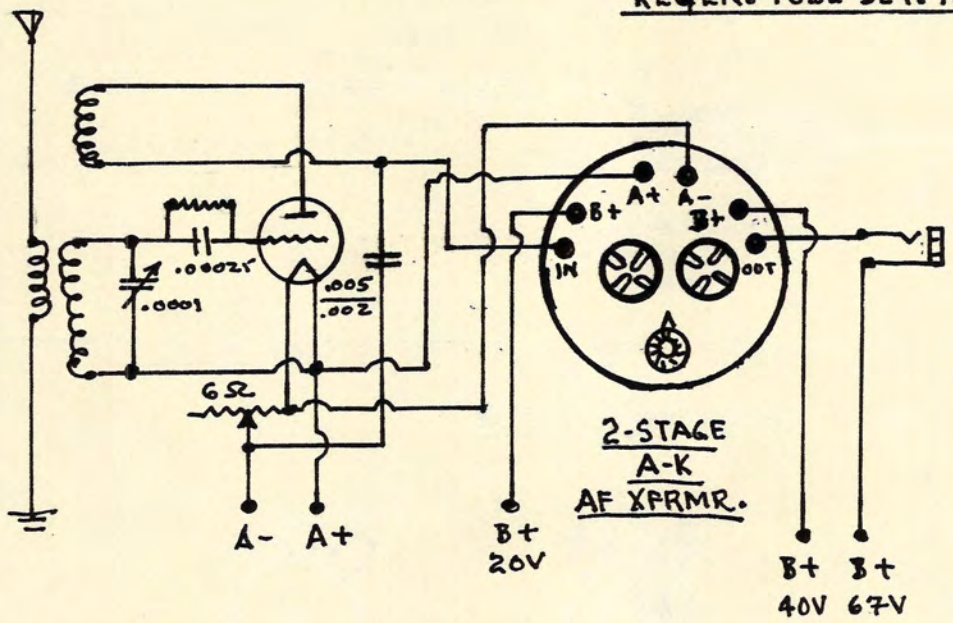
"C" TYPE
2W
Contact Arm
GND. to Shaft

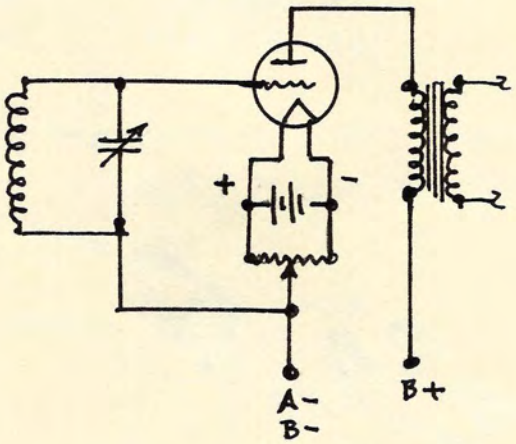
"E" TYPE
9W
Contact Arm
GND to Shaft

INTERNAL DETAILS OF THE JONES MULTI-PLUG:



REGEN. TUBE DET. HOOK-UP; 1926





PROPER BIAS ON DET. GRID INSTEAD OF USING A GRID-LEAK & CONDENSER.
(POT. ARM MAY BE LEFT DISCONNECTED, THE (-) GOING TO A- ON BATTERY.)

(1926)

CAUSES OF OSCILLATION

There are 4 principle causes of oscillation:

1. Magnetic Field Coupling
2. Conductive Coupling
3. Capacitative Coupling
4. Magnetic Loop

Secondary Causes:

1. Too high plate voltage.
2. Too many turns in plate coil.
3. FIL voltage too high.
4. Insufficient ANT load.
5. Insufficient by-pass across B+ end of plate coil.
6. Too low grid bias on tubes.
7. Poorly evacuated tubes.
8. Unbalanced sexion of ganged condenser.
9. Unmatched coils in tuning circuit.

Screen-grid voltage too low.

11. Poor or no GND connexion.
12. Shielding not grounded.
13. Poor or leaky shielding.
14. Neutralisation may be out of balance.
15. Coupling between PRI and SEC too close.

Magnetic Field Coupling:

1. RF inductances too close to each other.
2. Unshielded AF xfrmrs.
3. RF coils located in incorrect inductance realtionship.

Conductive Coupling:

1. In AC sets: RF and AF FIL supply taken from same source, instead of separate supply for RF and AF.
2. Insufficient by-pass capacity across grid-biasing resistors (in AC sets).

Capacitative Coupling:

1. Condenser and coil too close together, giving rise to an electrostatic condition.
2. Condensers too close together.
3. Grid and plate leads located too close to each other. As a rule of thumb: 1.5" to 2" separation is good.

Magnetic Loop:

1. Grid wires located in a field set-up by A- and B+ wires.

CAUSES OF OSCILLATION (Continued):

2. Grid wires located in a field set-up by A- and A+ wires.
3. Plate wires in fields, as above.
4. Coils located between loops.

Even in the absence of a great degree of understanding of the circuit, an orderly search predicated upon the above listed pointers can result in success. Patience is a pre-requisite.

* * * *

WARNING OF EARLY BATTERY CHARGERS!!

Many early chargers used an autoformer, which was essentially one winding across a portion of which a tap was taken to secure the necessary low voltage for the bulb - usually known as "TUNGAR". Thus, one side of the charger was grounded to one side of the power lines. Since the set was also grounded, disastrous results could occur to all tube filaments. As a precaution, connect a 1-MFD in series with the GND lead of the set. A grid-leak of around .5 megohms can be connected across the condenser, allowing any ANT charges to leak to earth.

* * * *

MOUNTING COILS ON A METAL CHASSIS NOTE:

Coils without shields should be mounted 1.5" above a metal chassis, or grounding metal plate.

* * *

BATTERY DRAIN QUICK-CHECK FOR 01A and 12A/71A TUBES:

(5) 01A	B+ = 30 mA	180 VDC = 8 mA	
(1) 12A/71A	A+ = 1.5 A	90 VDC = 3.5 mA	
		45 VDC = 2 mA	
		74 VDC = 0 mA	

* * *

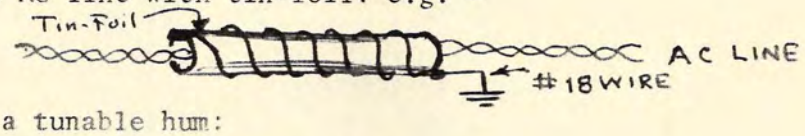
HUM ELIMINATION NOTES

1. Hum can be caused by running the pwr. xfrmr. at too high a PRI voltage. If xfrmr. has no PRI taps, incorporate a suitable resistance. This is particularly valid for FADA rcvrs. of the 40-series.

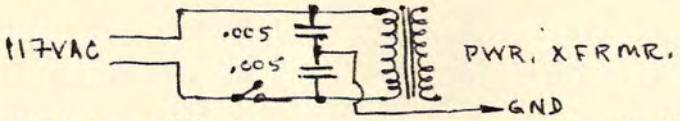
2. Hum ripple may be eliminated by a second filter in series with DC output sexion from pwr. pack.

3. To reduce AC hum, substitute an high inductance grid-choke for the grid-leak of the last AF tube.

4. Shield the AC line with tin-foil: e.g. -



5. To reduce a tunable hum:



6. Try inserting a 10W rheostat across the FIL winding of the pwr. xfrmr.

7. Twist leads from xfrmr. SEC to Grid and C- connexions:

8. Hum can be caused by:
   Defective DET input filter - ANT coil open - open output filter - open grid or line-filter - poor ground connexion - poor shielding - open loop ANT - open VOL control - fixed bias on some grids missing - fixed bias supply filter cap. defective (open circuit or low capacitance) - RF/IF/MIX/OSC grid leads too close to FIL or AC pwr. leads - defective by-pass cap. - heater to cathode short-circuit in tube, especially such tubes as 1LN5, 117Z6, 3Q5, et. al.

9. If rcvr. uses xfrmr-powered Selenium B+, hum can sometimes be eliminated by reversing xfrmr. high voltage SEC leads.

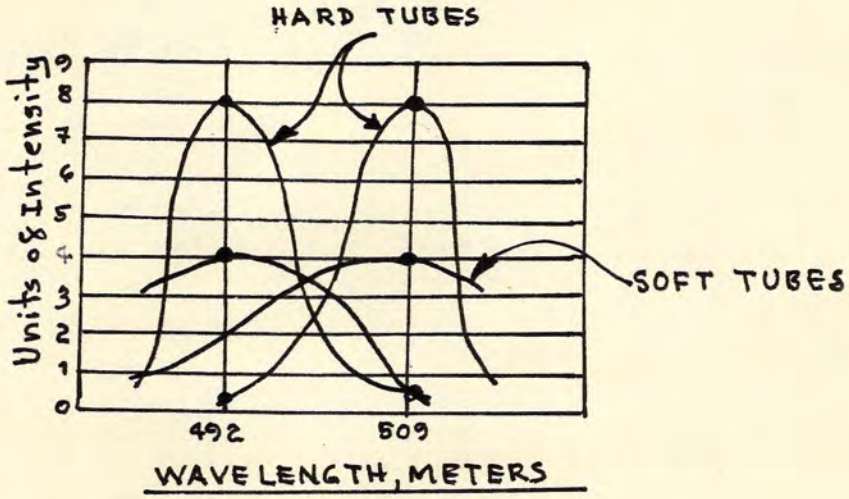
"HARD" TUBES vs. "SOFT" TUBES

One of the many wheels-within-wheels editorial controversies one may find in radio media of the early Twenties was the one treating of so-called "soft" versus "hard" tubes. What distinguished a 'soft' from a 'hard' tube was the centre of the controversy, in as much as tubes of the same series - e.g., 01A - could be soft or hard.

The graph below illustrates the real difference between the two types of tubes, any series, using signals broadcast at 492 and 509 meters - both signals being of equal transmitting power.

How do you determine whether a tube is 'soft' or 'hard? - you use your ears. A soft tube usually required 16 to 25 volts on the plate. When the proper voltage was applied to a soft tube plate, there was a slight "hiss", usually referred to as a "soft" hiss in the media. When you heard the hiss, you knew that the tube plate was receiving its proper voltage. This was an easy check, obviously, but there were reports of set-constructors who created loud hisses, thus ruining their tubes.

As a rule of thumb: for greater DX, use a soft tube; for local BC reception, use a hard tube. Naturally, this soft vs. hard distinction between tubes did not continue, as the technology of tube manufacture advanced to where by the early Thirties, such distinctions could not be made. However, if you have a batch of early tubes - 99, WD-11, 01A, etc. - you might want to test them for softness.



RELATIVE EFFICIENCY OF "SOFT" vs. "HARD" TUBES USED AS DETECTORS

COUPLING - CAPACITOR COMMENTS

The conventional coupling-capacitors ranged from 0.01 mfd to 0.1 mfd, and on occasion, to 0.001 mfd. The capacity of these condensers determined the frequency response - the lower frequencies increasing with an increase in condenser value. When the coupling-capacitor became short-circuited, which happened frequently, all reception stopt. The grid-bias of the tube connected to the shorted condenser would go positive and there would be an increase in plate current.

If the grid-bias is 45V, which was also conventional for the period - i.e., the late Twenties - and the true voltage on the preceeding tube plate was almost the same, the measured grid-bias would be Zero if you had a shorted condenser. When the preceeding plate voltage was higher, then the bias voltage will be positive by an amount approximately equal to the difference.

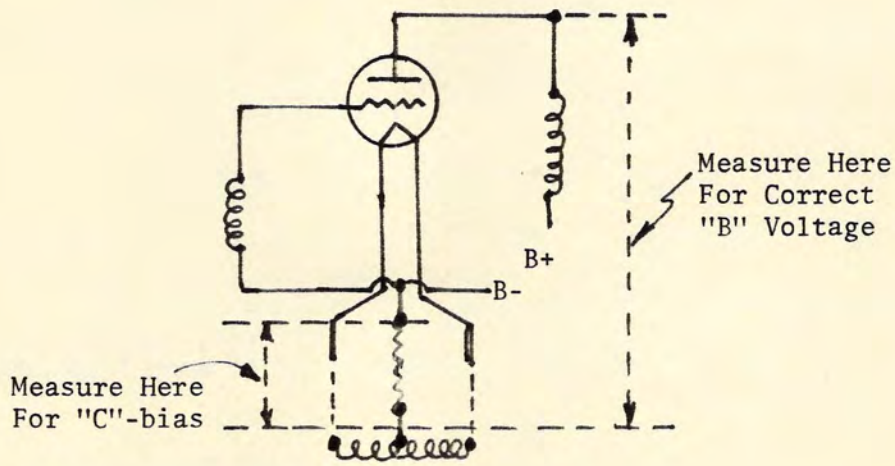
In brief, a short-circuited coupling-condenser results immediately in a very weak signal and greatly distorted signal output.

When a resistance-coupled AF amplifier coupling-condenser becomes open, there would usually be no reception, or very weak and distorted signals - similar to a short-circuited condenser. Muffled output is not the same thing, as muffled output was usually caused by a leaking coupling-capacitor. This defect could also be indicated by a positive grid-bias, the value depending upon the amount of leakage.

The simplest and quickest method for isolating a shorted or open coupling-condenser was to bridge another condenser across it. If the output improved, the condenser was open. What was rarely mentioned in early trouble-shooting listings was the fact that your fingers, in proximity with the coupling-capacitor could cause an audio oscillation.

Bridging a suspect condenser that is leaking was not feasible, as a leaking condenser could not be bridged. To check for a leaking unit, it had to be removed and then tested - or simply removed and replaced with a known good coupling-capacitor.

PROPER VOLTAGE MEASUREMENTS

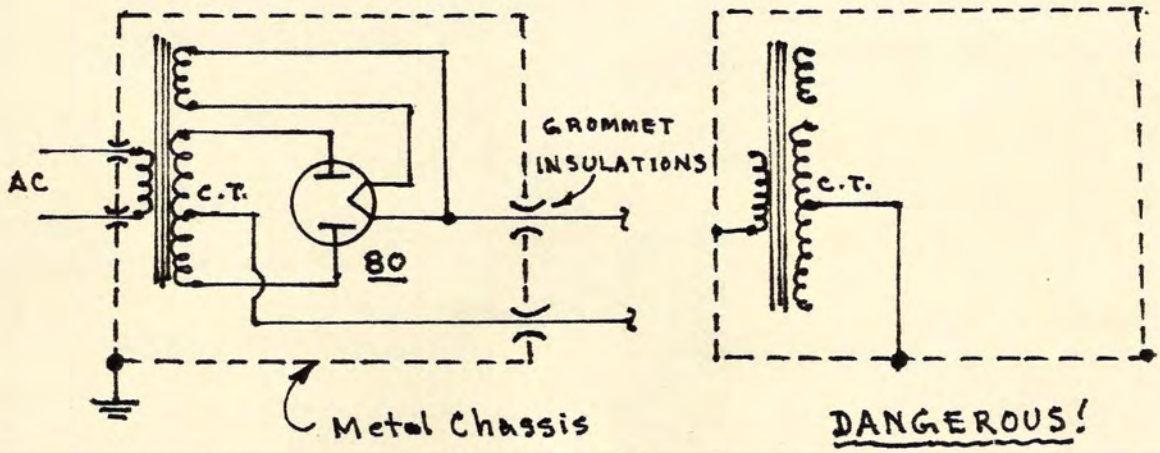


The sketch shows the two points at which voltage readings for AC tubes may be secured. A high resistance VM placed across the extremities of the grid-bias resistor, the meter will register the voltage actually applied to the grid. If a high resistance VM is clipt between the plate and the center-tap of the FIL transformer, the reading will be the actual voltage applied to the plate.

Plate voltage should never be measured between the plate and B-, as this reading would be fictitious when AC tubes are used, since it would include the voltage applied to the grid. The sketch above shows how to secure accurate voltage readings.

* * *

POWER SUPPLY SAFETY NOTE:



TU = TRANSMISSION UNIT vs. DECIBEL:

TU was an expression used to symbolise the power ratio of a circuit. It was used first by the Wire Communications Company, to denote gain or degree of amplification in amplifiers; the loss in any type of transmission circuit; or for comparing the strength of two signals. Input and output circuits bear a definite relation to each other, being known as the power ratio. This ratio is expressed in TU as follows:

$$N = 10\log \frac{P2}{P1}$$

where:

N = number of transmission units (equal to 10 times the logarithm - to the base 10) of the power ratio.
P2 = output measured in mW.
P1 = input measured in mW.

In the Autumn of 1929 the Bell telephone engineers decided to do away with the TU symbol, and invented a new one - the "decibel". It was intended to refer simply to the efficiency of telephone circuits. The "bel" was selected in honour of Alex. G. Bell, but because it was larger than needed in practice, "deci-" was added to it, making it one-tenth of a "bel".

Today, the decibel is firmly fixed in everyman's vocabulary, even though it is frequently misused, even by engineers.

* * *

THE VALUE OF C-BIAS TO 2-STAGE XFRMR.-COUPLED AF AMPLIFIERS:

The accompanying table shows the total plate current drain of a 2-stage xfrmr.-cpld. AF amplifier, with various values of plate potential and C-battery. Tube used = 01As, but values shown are averages for several types of tubes. The exact values are immaterial, since they exert only a small effect upon the actual plate current drain, a variance of from 100 to 300 ohms being entirely negligible.

Pl. Volt.	Total Drain*	With -3V	With -4,5V
130	18 mA	13 mA	10.3 mA
108	14 "	8 "	7 mA
85	10 mA	6 "	5 "
65	6.3 mA	3 mA	2.5 mA
40	3.3 mA	(No C-battery Used.)	

* = No C-Battery Used.

* * *

NOTES ON MATCHING IMPEDANCES

When two elements or components in an electrical circuit such as a radio circuit, the efficiency of the circuit depends on the relations existing between the impedances of the components coupled together, and some form of "adjusting" transformer is required.

The coupling device is inserted to transfer the maximum of voltage, current, or power to the receiving unit.

In the tube-type amplifier, the object was to obtain as high a voltage as possible in the grid of the following tube. The load on the coupling device, usually a transformer, was practically an open circuit. The object of that was to obtain as high an input impedance in the transformer as was suitable.

EXAMPLE:

A transformer having a straight 2:1 ratio (10K PRI and 5K SEC, e.g.) tells you nothing unless it is understood that what is needed is a transformer suitable for use between 10K and 5K. A transformer with an open circuit impedance would be quite unsuitable, as it would not be "matched" to the load impedances .

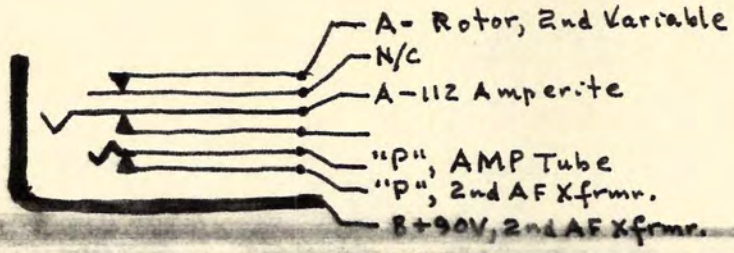
The object would not be to get maximum power into the transformer, but to get it into the load. Thus, the impedance ratio, not the actual impedance is the important factor. The open circuit impedance is of importance, however, as it would form a load in parallel with the useful load.

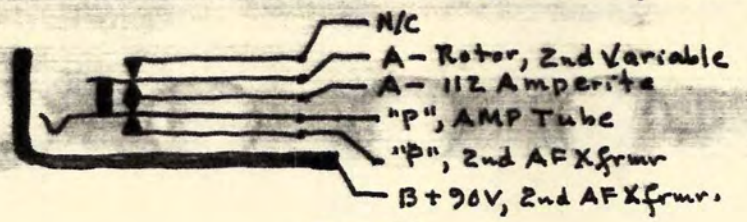
A transformer with a 10K PRI working out of a 10K source would have half of the power lost in the transformer. The open impedance circuit must be several times the impedance of the loads being coupled together for an efficient transfer of energy.

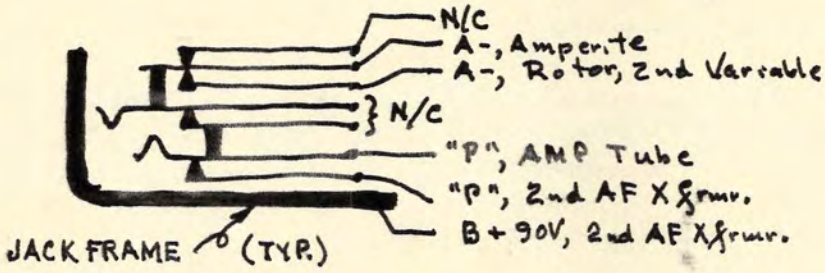
A transformer with a 10K tube impedance to a speaker, for example, should be 50K or more, open circuit impedance. It might be noted that the behavior of a speaker depends on the amplifier with which it is used, and the effect of speaker/amplifier is NOT additive.

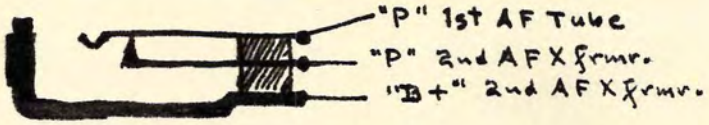
With the advent of the 50 tube, reproduction was frequently poor with some dynamic speakers. This was always due to a mismatch between the speaker input xfrmr. and the power tube. The early "universal" input xfrmrs. were never suitable for the 50; thus, xfrmrs. that functioned well with the 71, 12A, 01A would not function well with the 71A, 45, or 50 tubes. If using the 50 tube appeals to you, try an output transformer of 4,000-ohms at 100 cycles, with 55 mA of current in the circuit.

AF JACK CONNEXIONS-Sht.1

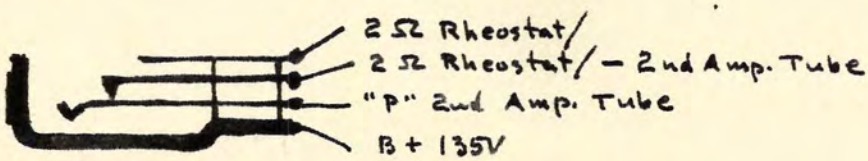




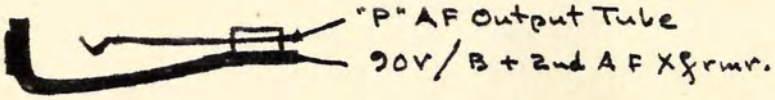




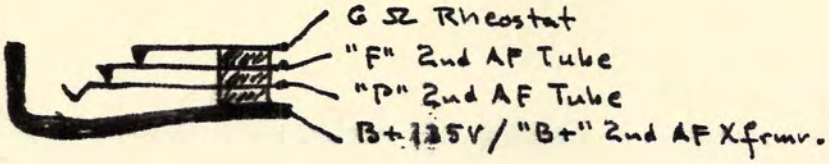
FIRST STAGE



SECOND STAGE

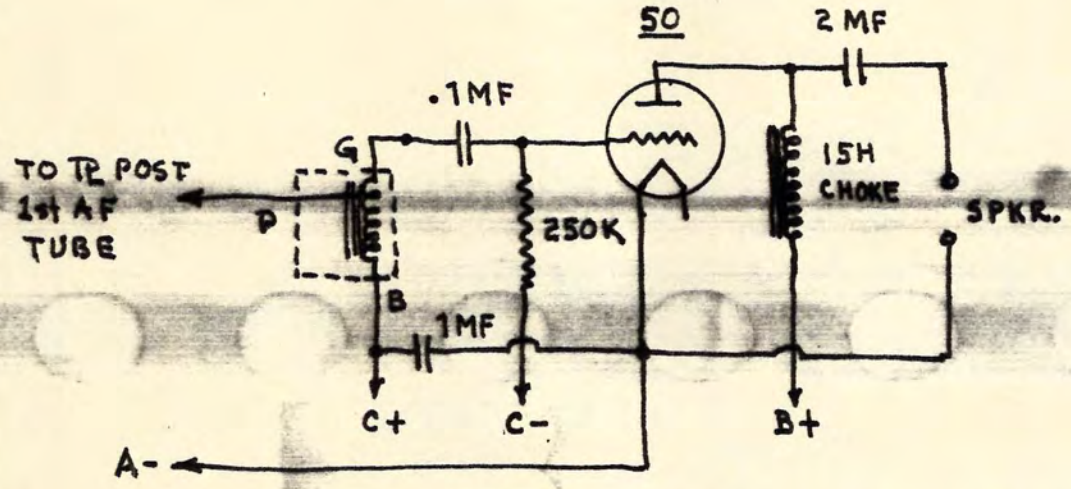


SINGLE JACK OUTPUT

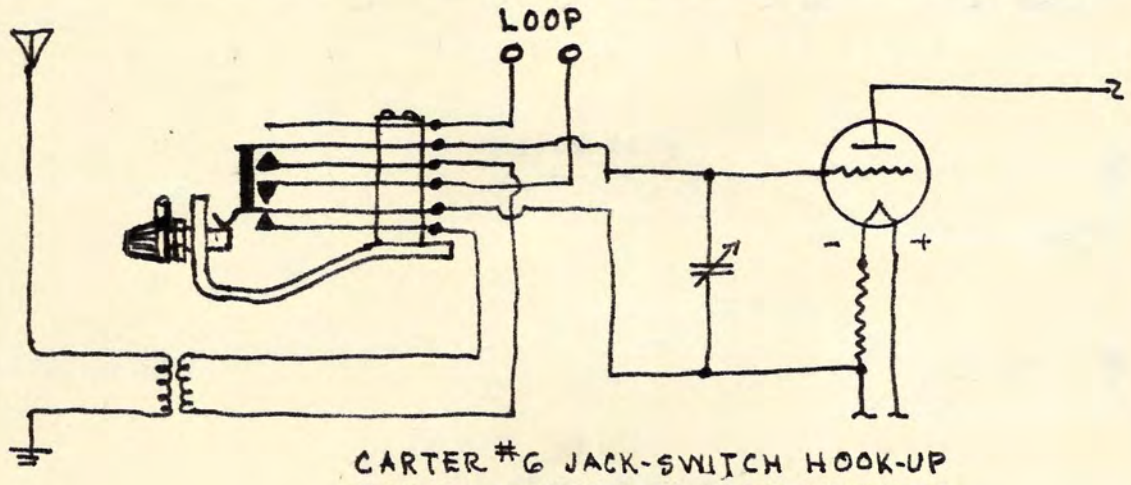


SECOND STAGE.

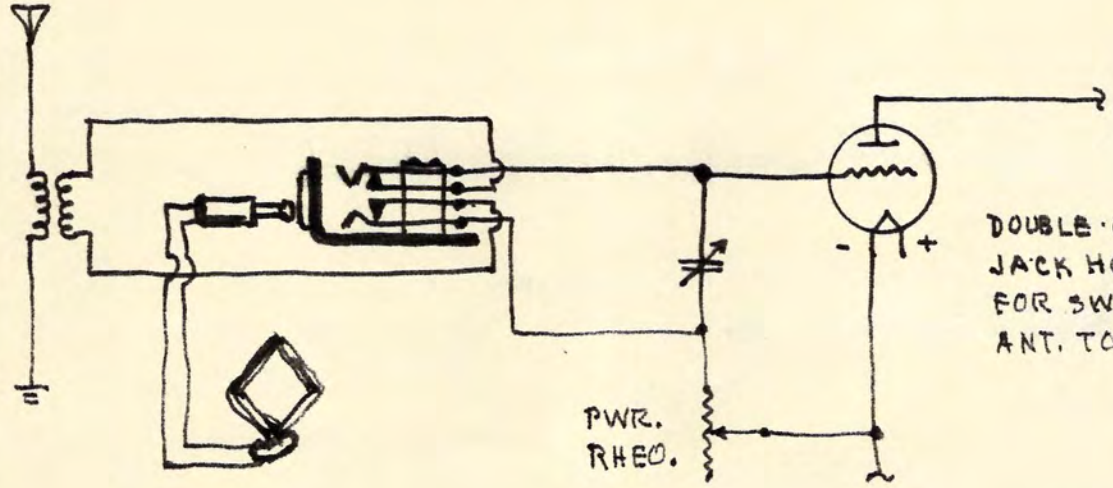
FIRST STAGE



INCORPORATING THORDARSON "AUTOFORMER" INTO "INFRADYNE 29" POWER AMPLIFIER.



CARTER #6 JACK-SWITCH HOOK-UP FOR SWITCHING LOOP TO ANTENNA



DOUBLE-CIRCUIT JACK HOOK-UP FOR SWITCHING ANT. TO LOOP

EARLY RADIO SCHEMATIC SYMBOLS

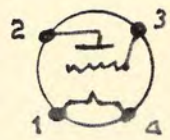
Ohmage:

Early Symbols: 3ω = 3 ohms 3M = 3 thousand ohms (*)
Modern Symbols: 3Ω = 3 ohms 3K = 3 thousand ohms

(*) = "M" is the Latin character for one thousand, and in the days when being educated was in vogue, the use of Latin and Greek designations in a variety of fields was common. Today, schematics show "M" as standing for Megohm.

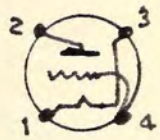
* * *

While tube-base diagrams are available in the usual references, such as the ARRL Hanbook, they are mixed in with all other tube-base diagrams. As a convenience in finding only vintage tube bases, the following have been culled from existing literature. (N/S) = no substitute.



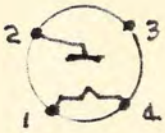
X99, 001, 00-A, 10, 20, 26, 30, 31, 40, 45, 50, 01A, 12A, 71A

22, 32 (N/S)



11 (N/S)

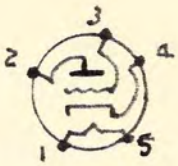
80, 82, 83 88, 5Z3



81 (N/S)

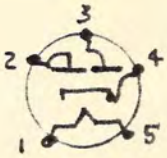
34, 1A4, 1B4, 32

24, 51, 36, 24A, 35, 64(N/S)

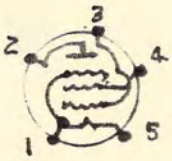


27, 37, 56, 76

49 (N/S), 46



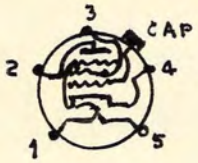
84, 6Z4



47 (N/S)

48 (N/S)

EARLY RADIO SCHEMATIC SYMBOLS, Sht. 4



15, 39, 39/44
38

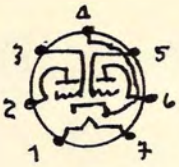
33 (N/S)

12Z3, I-v°
1-V, 1

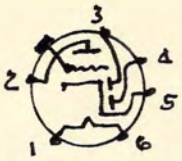
19 (N/S)

85 (N/S)

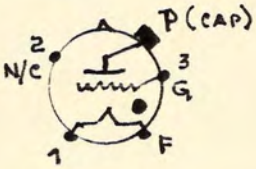
57, 58, 77, 78,
(N/S) 89



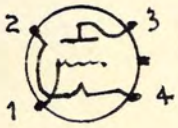
53(N/S)



75 (6H6)

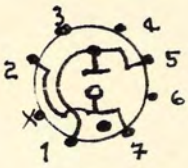


81A (N/S)

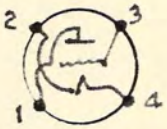


V99(N/S)

41, 42,43,
2A5

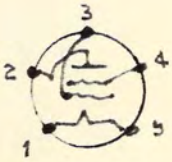


0A2



WD-11

18, 2A5



52,49

41, 42, 48

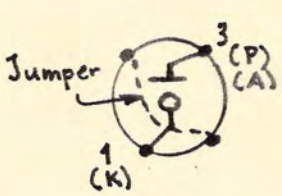
79

872

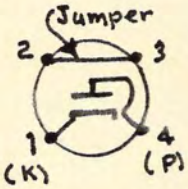
RK-19

59

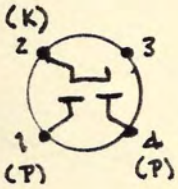
BASES OF VINTAGE TUBE RECTIFIERS, VOLTAGE REGULATORS, BALLASTS



874



"B-R"

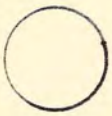


B-A, B-H

81

WEHENELT
(AC Rect.)

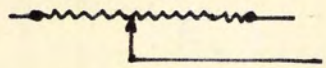
866, 866-A



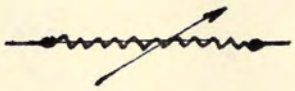
RECTIFIER DATA:

	Fil. Volts	Amp.	Supp.	RMS	DC mA	Volt. Drop
82	F/W	2.5	3	AC/DC	500V	15
B-A	F/W	N/A	N/A	N/A	350V	350	300
B-H	F/W	N/A	N/A	N/A	350	125	300
80	F/W	5.0	2	AC/DC	350	125	N/A
81	H/W	7.5	1.25	AC/DC	700	85	N/A
66 CAP	H/W	2.5	5	N/A	7,500	600	N/A

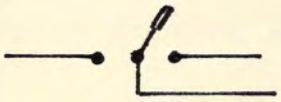
EARLY RADIO SCHEMATIC SYMBOLS, Sht. 2



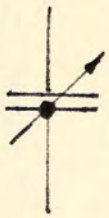
Adjustable Resistor By Taps



Continuously Variable Resistance

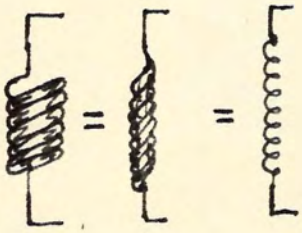


Knife-Switch S.P.S.T.

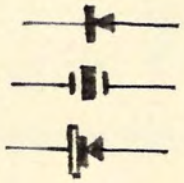


Variable Condenser With Rotor Indicated

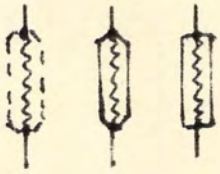
Rotor Is Bottom Arrow or Line



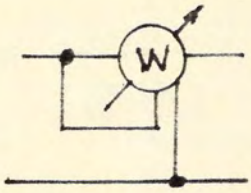
Inductances



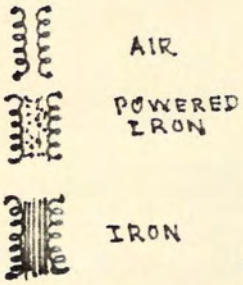
Crystals (Xtls.)



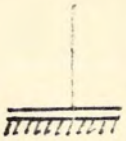
Filament Ballast



Watt-Meter



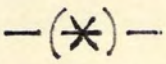
Transformers



Counter-Poise

Chassis

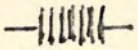
Ground



Rotary Non-Syncronous

Rotary Synchronous

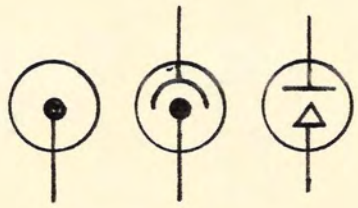
Open Type



Quenched

SPARK GAPS

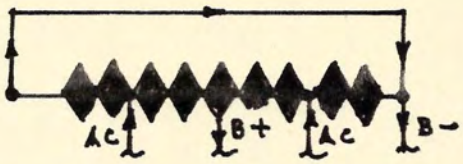
EARLY RADIO SCHEMATICS SYMBOLS, Sht. 3



Voltage Regulating Tubes

Gaseous Full-Wave Rectifier

Glow-Tube

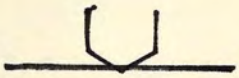


Dry Electrolytic Rectifier

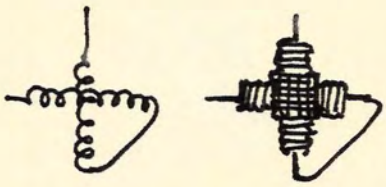
Electrolytic Detector

Electrolytic Rectifier

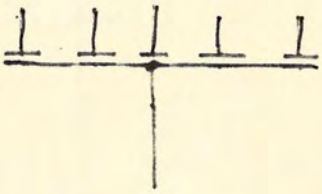
Anti-Capacity Switch



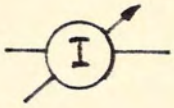
Thermo-Element



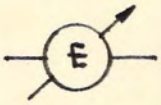
Variometers



Fixed Condenser Block (Filter or By-Pass)



Ammeter

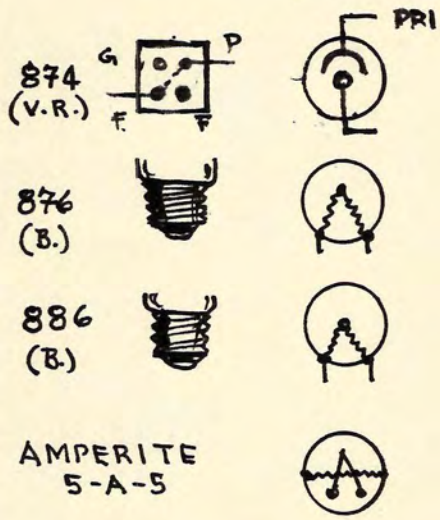


Voltmeters

Frequency Meter

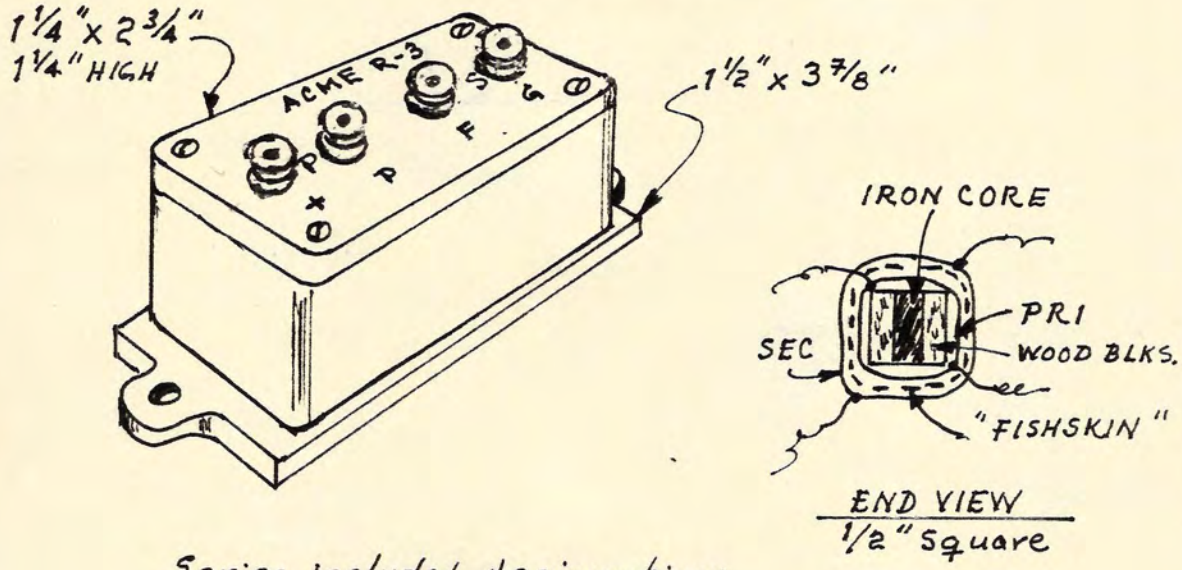
Galvanometer

RECTIFIERS, VOLTAGE REGULATORS, BALLAST

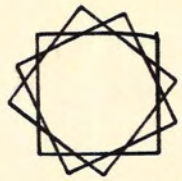


	OPERATING VOLTAGE	STARTING VOLTAGE	OPERATING CURRENT
874 (V.R.)	90	125	10-50mA
876 (B.)	1-7A	(RANGE = 40-60V)	
886 (B.)	2.5A	(RANGE = 40-60V)	
AMPERITE 5-A-5	110VAC		

ACME RF XFRM. DETAILS, 1924



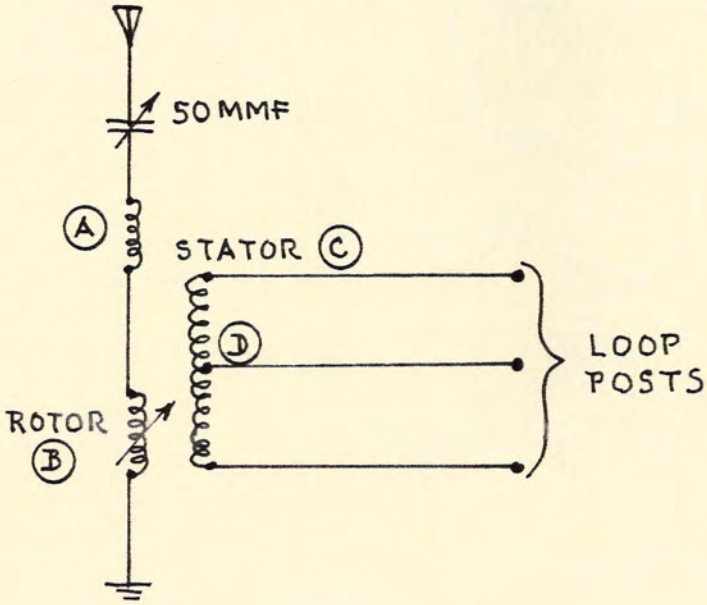
Series included designations R-2, R-3, R-4. Physical configurations identical. Coils were potted in beeswax. Molded Bakelite Casings, black. ACME sometimes used "C-" in lieu of "A-" or "G", particularly w/ their ill-fated "D"-Coil set of 1925. "S"-"P" = SEC & PRI.



BASKETWEAVE
COIL SYMBOL

SPIDERWEAVE
COIL SYMBOL

ANT CONNECTIONS FOR 3-POINT LOOP



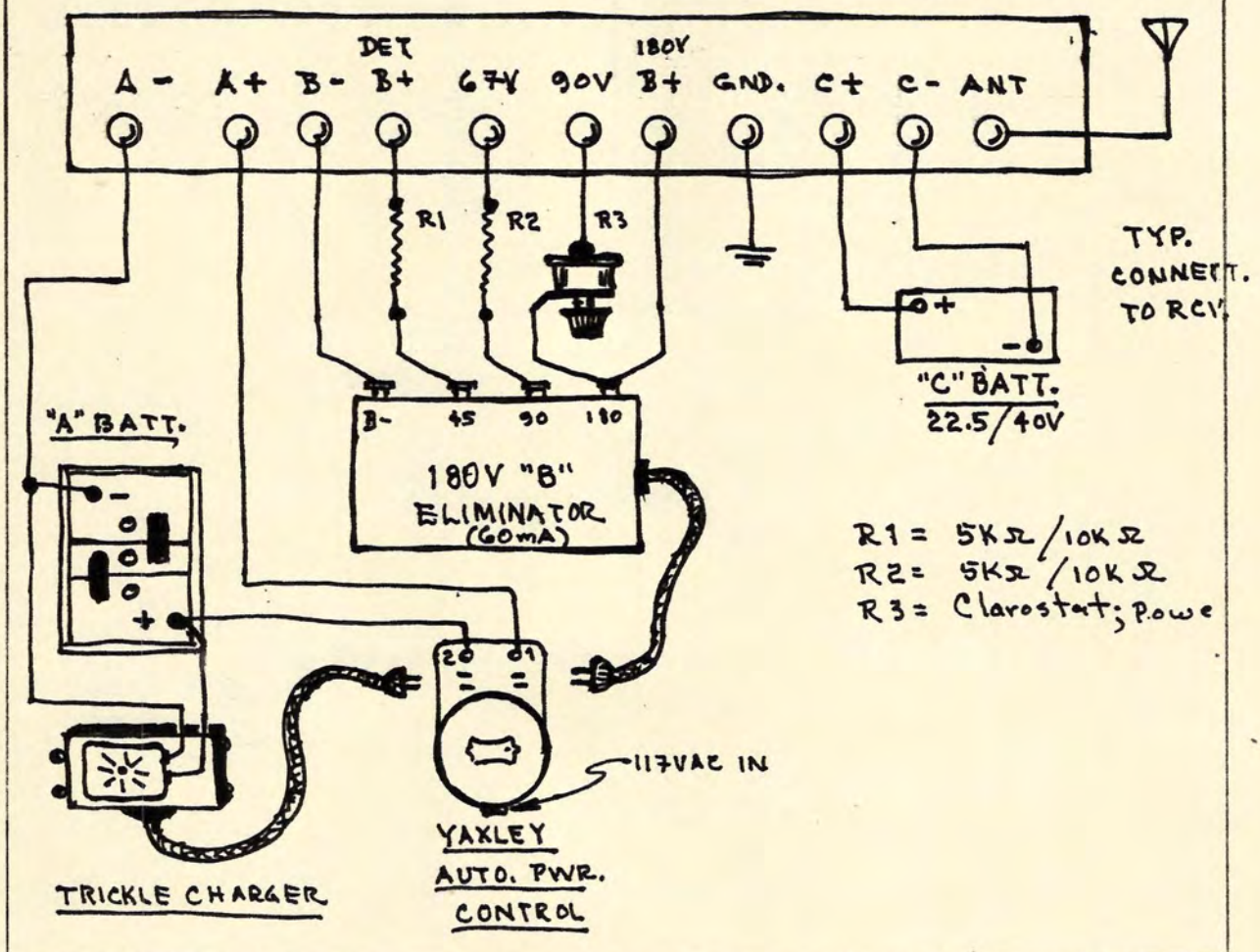
A = 100T #24 DCC, 2.5" Ø FORM. (OR 100T HONEY-COMB COIL.)

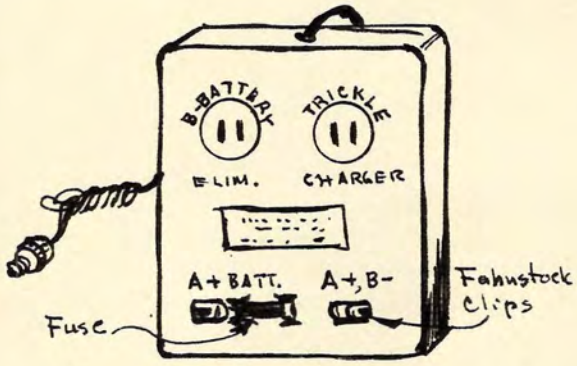
B = 20T #24-#26 DCC, 1.75" Ø FORM.

C = 70T #24 DCC, 2.5" Ø FORM.

D = TAPT @ 35T.

B-ELIMINATOR & TRICKLE-CHARGER HOOK-UP (1927)

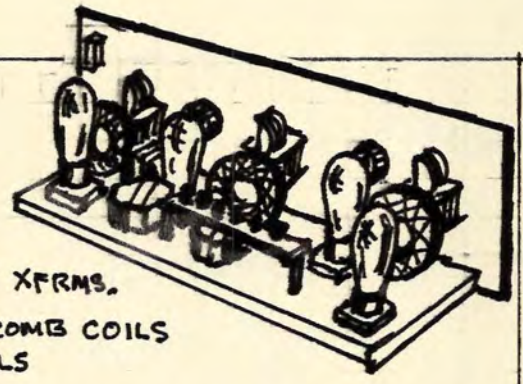




AUTOMATIC POWER SWITCH

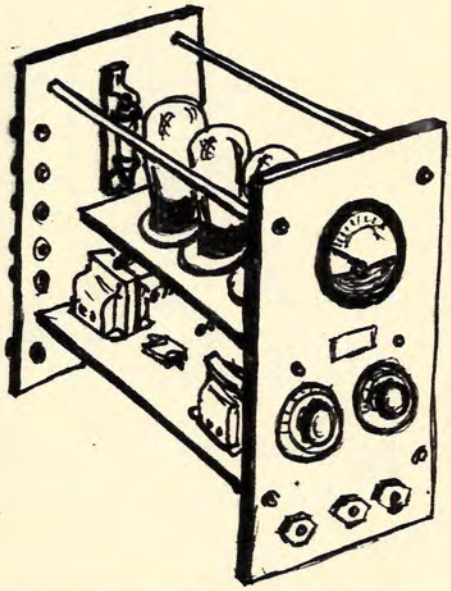
Liberty Bell Mfg. Co.

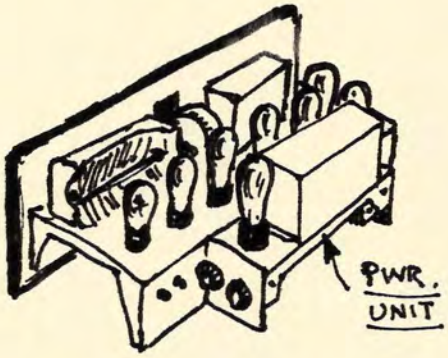
(1926 - $5)



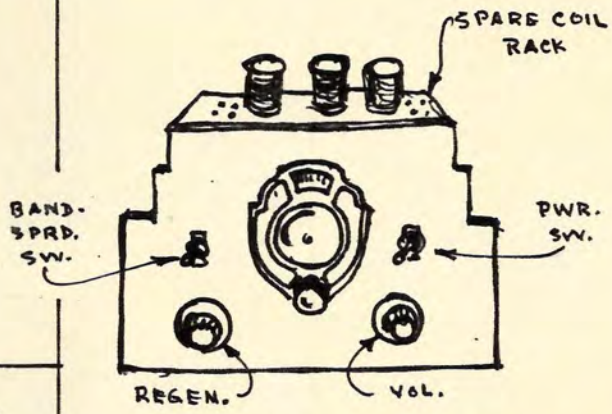
CONFIGURATION, 1927
(4-TUBE T.R.F.)

CONFIGURATIONS

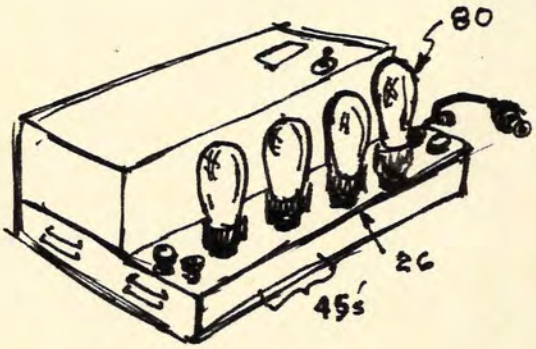




CONFIGURATION, 1929
(8-TUBE SUPER-HET)



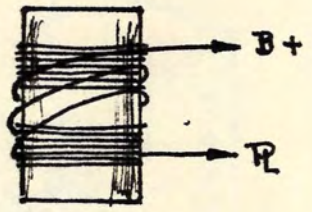
4-IN-2 ALL-WAVE AC 2-TUBE

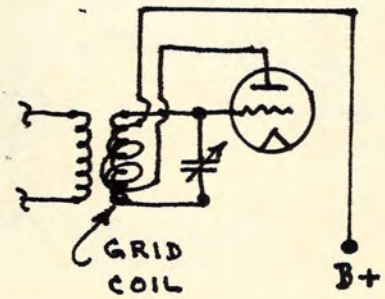


BOSWORTH Model 1A
PWR. AMP., 1929

TECHNICAL TIPS SHEET

IMPROVING T.R.F. SENSITIVITY:

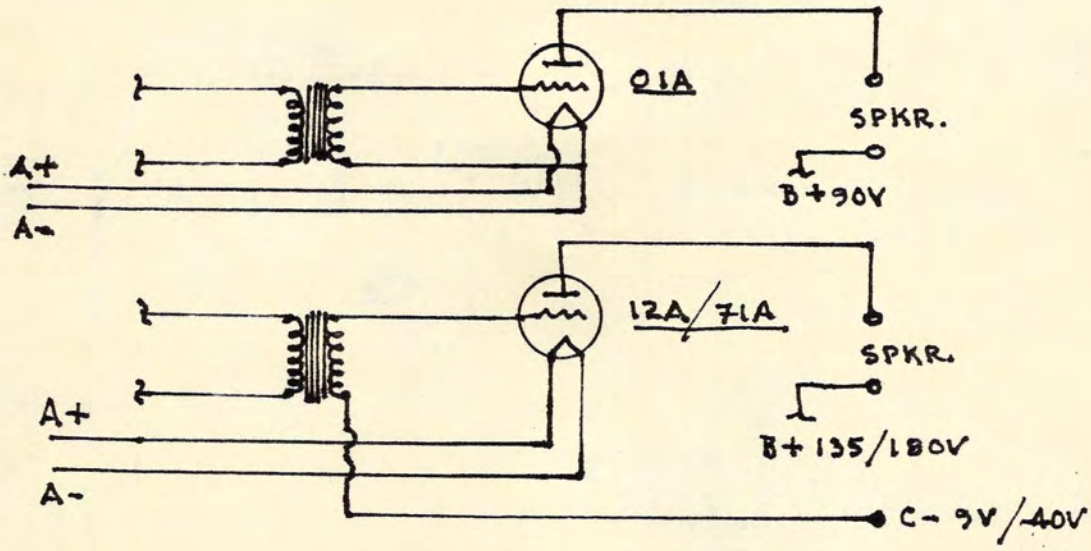




2 or 3T #26 DCC on outside of Grid Coil, wound in same direction.

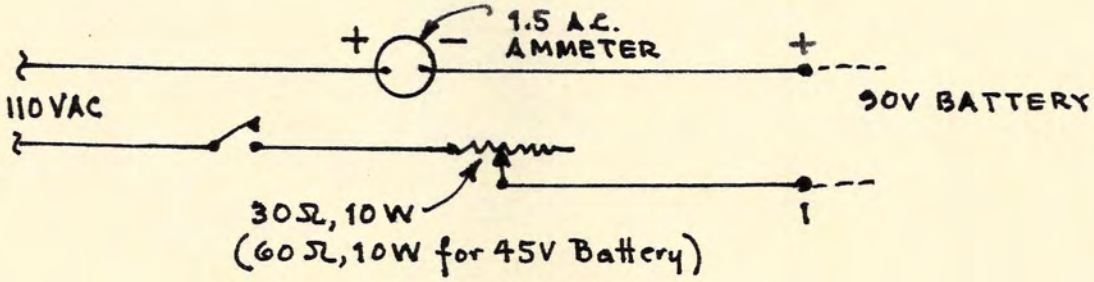
IF SET OSCILLATES, REMOVE ONE TURN @ A TIME UNTIL SET OPERATES JUST BELOW POINT of OSCILLATION.

ADDING A POWER TUBE TO OLD CIRCUITS:

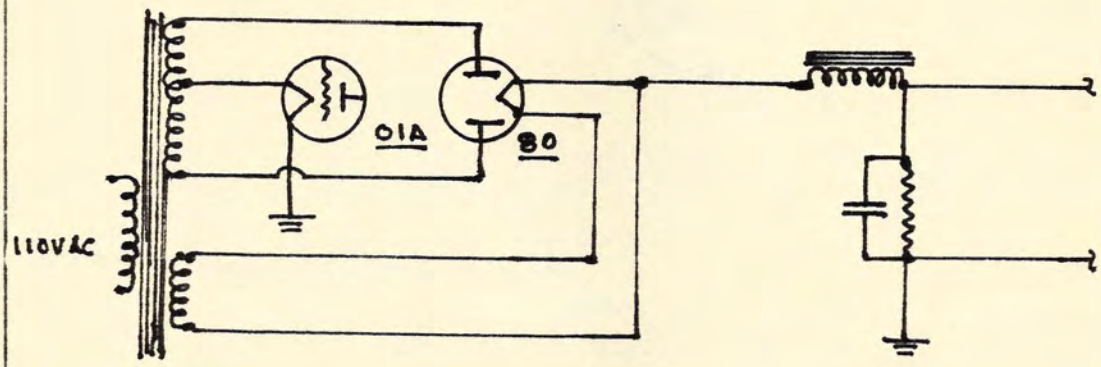


TECHNICAL TIPS SHEET

CHARGER FOR 90V BATTERIES:

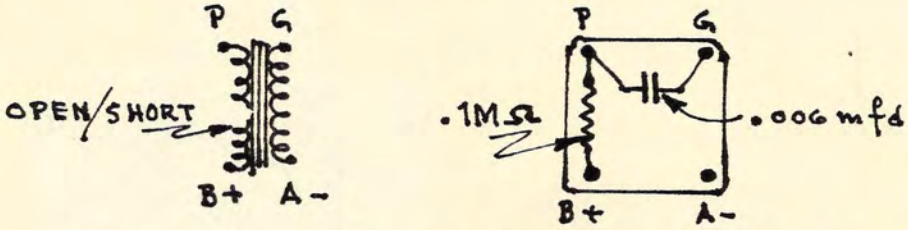


01A AS RECTIFIER FUSE:



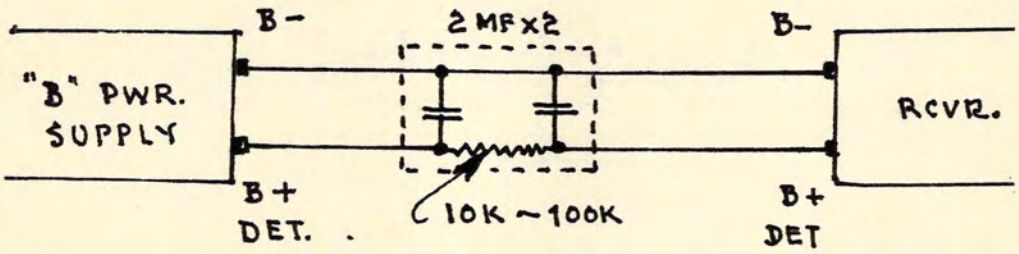
Chassis GND. assumed. 01A will "blow" on a short.

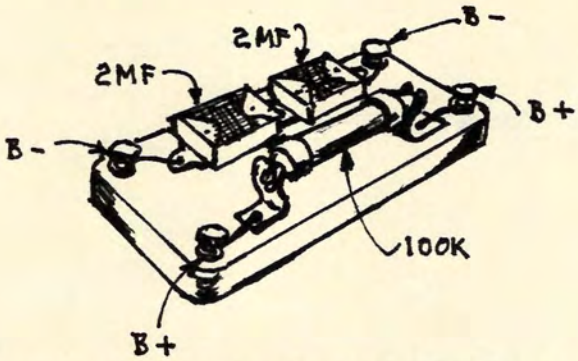
IMPEDANCE-COUPLED DEVICE FROM SHORTED XFRMR.:



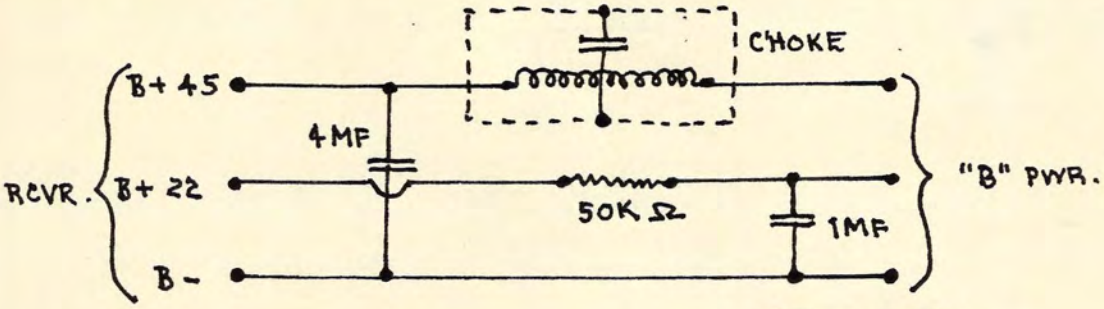
Device affects resistance-capacity coupling w/ an impedance leak, & will give good tone quality.

ANTI-MOTOR-BOATING CIRCUITRY, Sht.1





SARGENT-RAYMENT ANTI-MOTOR-BOATING FILTER, 1927:



(Choke is/was similar to S-M 251 output xfrmr.)

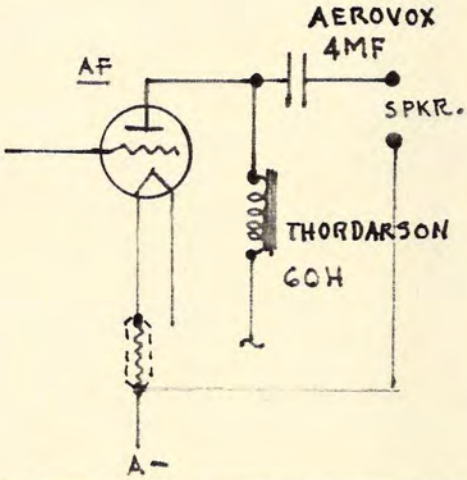
DAVEN

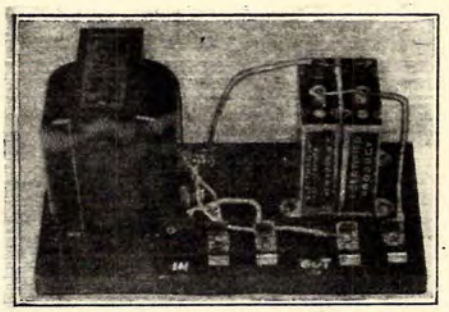
ANTI-MOTOR-BOATING

DEVICE - 1924

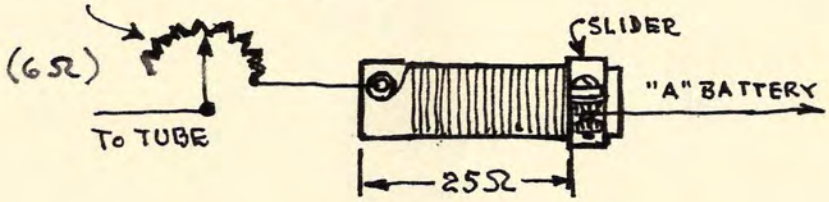
ANTI-MOTOR-BOATING CIRCUITRY, Sht.2

With the early circuits, the use of a separate battery for the DET was always recommended. For awhile, there were admonishments to by-pass the terminals on the B-eliminator, but such a practice was of very little avail, unless the condenser was on the order of 10 to 100 MFD. If using an eliminator with an impedance high enough to cause oscillation, a condenser of 10 MFD, or more, would help. The use of impedance-coupling in the last stage, when using an eliminator, is superior to other types. Such impedance devices were frequently called "tone filters". An example of an early impedance-coupler as an adjunct to a breadboarded circuit is depicted below:



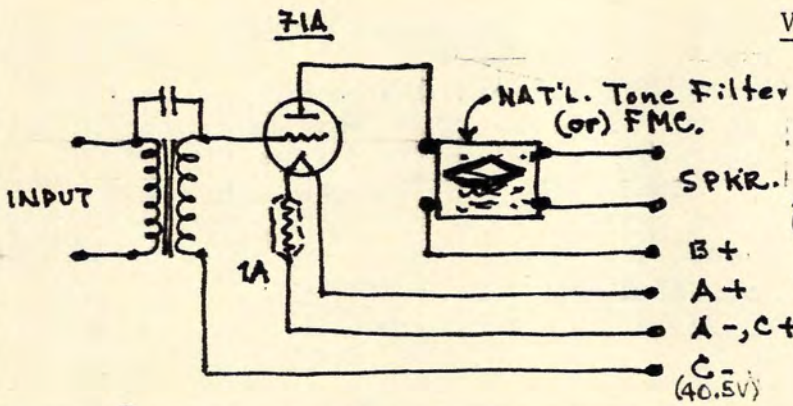


Original Rheostat In Set



CUTLER-HAMMER resistance unit for use when converting V99 tubes to 01As. A socket change is required, as the 99 FIL terminals are different. Another use was to convert a 6-ohm rheostat to a 30-ohm rheostat.

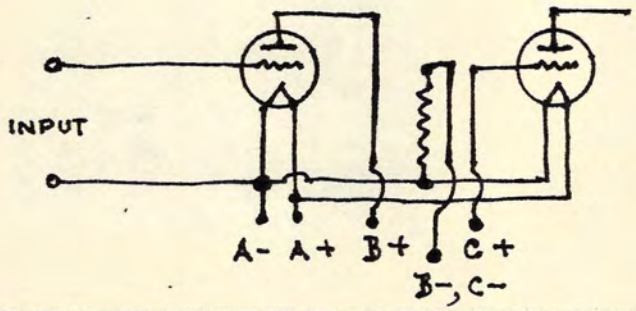
TECHNICAL TIPS SHEET



VOLUME BOOSTER

Baseb'd. = 4.5" x 5" x ½"
Dual-Impedance Xfrmr.

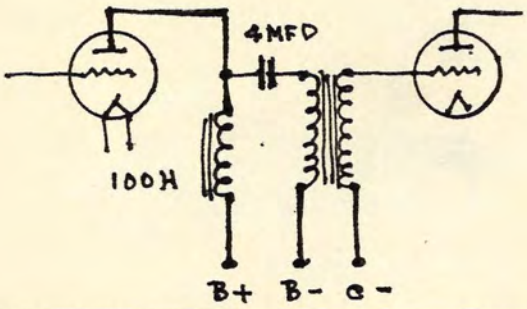
Connect one of these to switch in set.



DC AF AMPLIFIER

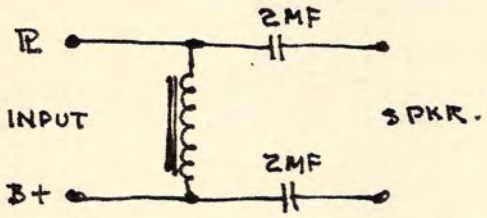
Cplng. Resistor = 500K.
C-Battery = 3/4.5V.
B+ = 7.5V.

Original design by Dr. H.P.Arnold, W.E., 1918.



PARALLEL PLATE-FEED

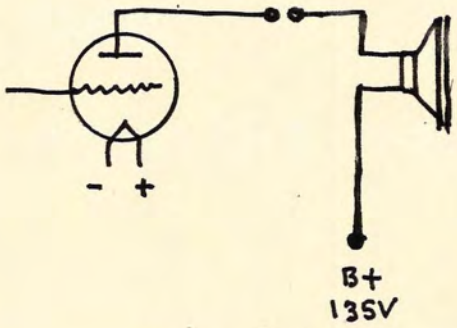
AF Xfrmr. = G.R. 285.
Choke = G.R. 369.



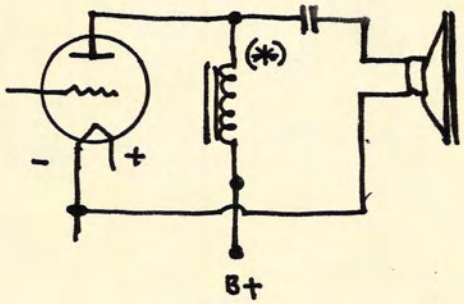
SPEAKER IMPEDANCE

Impedance = G.R. 587-A;
DC resistance of 250 ohms

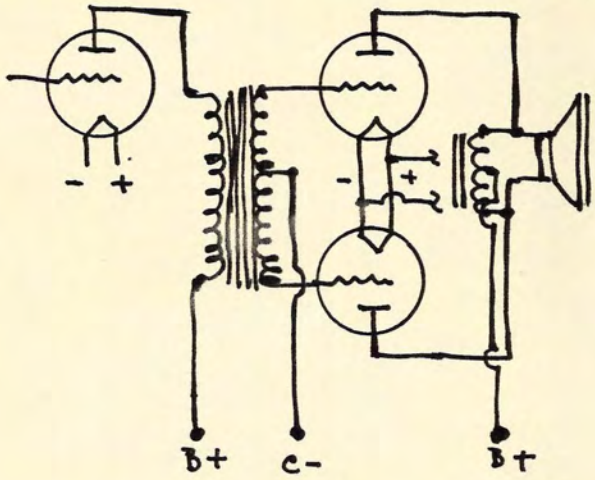
TYPICAL AUDIO OUTPUT CIRCUITS, 1927



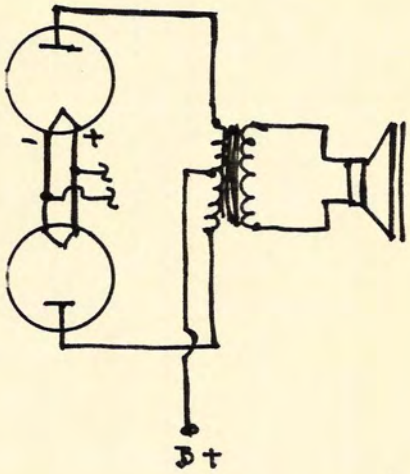
SINGLE TUBE OUTPUT



SINGLE TUBE OUTPUT

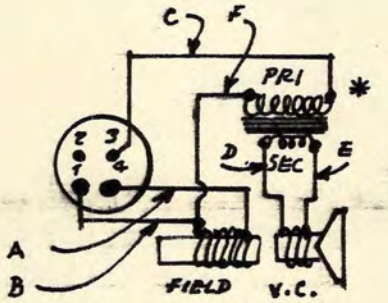


PUSH-PULL

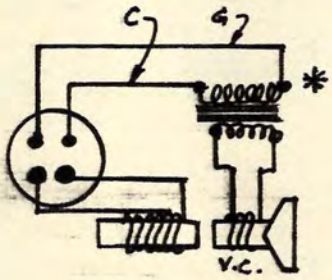


PUSH- PULL

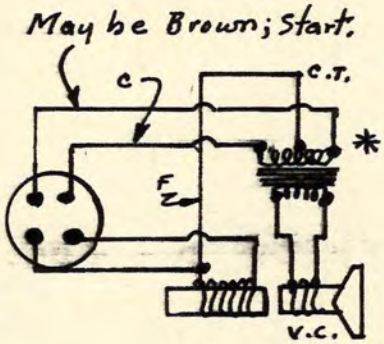
(*) = The impedance-type choke shown can be the Secondary winding of an AF transformer that has a shorted or open Primary winding.



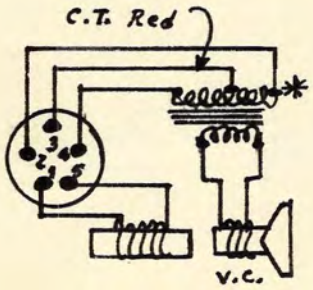
STD. 3-WIRE CONN.
(Typical Coding)



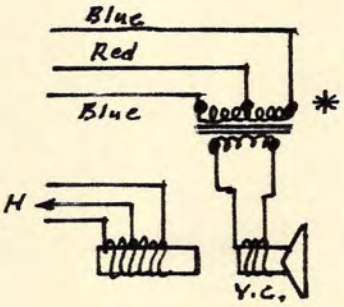
STD. 4-WIRE CONN.



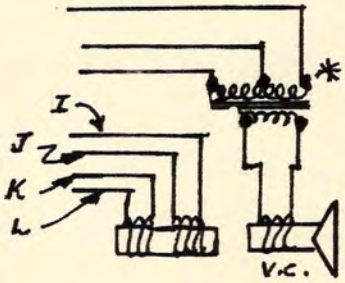
STD. 4-WIRE P-P



STD. 5-WIRE P-P



WHEN FIELD COIL IS TAPT



SEPERATE FIELD COILS

*= SPEAKER XFRMR.

All 2-colour leads have evenly spaced stripes.

A = Black & Red, start.
B = Yellow & Red, Finish.
C = Blue, Finish; PRI
D = Black, start. } SEC
E = Green, Finish } SEC
F = Red Jumper; PRI.
G = Red; start.
H = Slate & Red, C.T.
I = Black & Green. } High Resist. Field
J = Yellow & Green. } High Resist. Field
K = Black & Red. } Low Resist. Field
L = Yellow & Red. } Low Resist. Field

STANDARD DYNAMIC SPEAKER LEAD COLOUR CODE & PLUG CONNEXIONS

NOTE

Where not shown, colour code same as Fig. 1.

SILVER ALL-WAVE REGENERATIVE ERRATA

Revised Coil Data

	Large Stator	Small Stator	Rotor
190 - 650 Meters	84 T	25 T	24 T
90 - 210 Meters	32 T	14 T	10 T
50 - 110 Meters	14 T	10 T	6 T

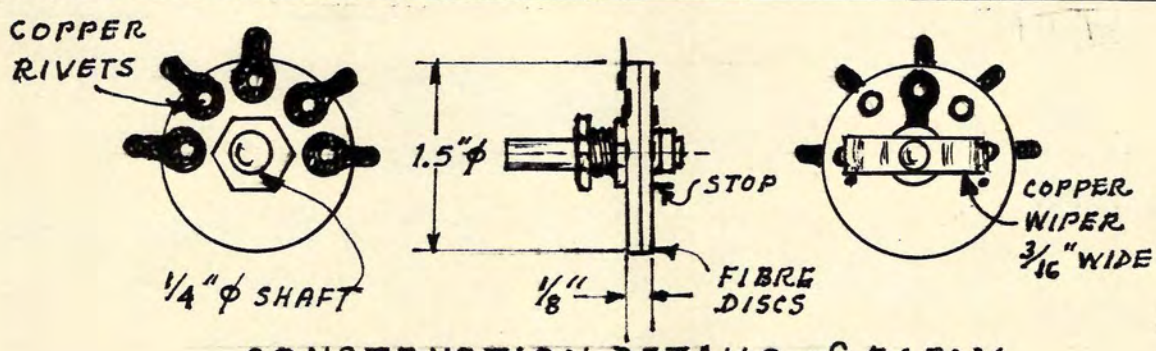
Data given in original RADIO article was in error.

(R 1-26)

LATTER-DAY Ce-Co LETTERED TUBES IDENTIFICATION:

DET & AMP.:	FIL V.	FIL A.	DET V	AMP V.	AMP C.	S.G. V.
C, B, BX	3	,06	45	90	4.5	-
01A	5	.25	45	90	4.5	-
RF22	3.3	.132	-	135	1.5 45	
N27	2.5	1.75	45	90	6	-
AC 24	2.5	1.75	-	180	1.5	75
POWER TUBES:						
E	3	.12	-	90	16.5	
F	5	.50	-	90	4.5	
F12A	5	.25	-	90	4.5	
J71	5	.50	-	90	16.5	
J71A	5	.375	-	90	16.5	
L45	2.5	1.5	-	250	-50	
L10	7.5	1.25	-	180	12	
L50	7.5	1.25	-	250	45	
AMPLIFIER TUBES:						
G	5	.25	90	60	-	
M26	1.5	1.05	-	90	6	
Radio Frequency:						
K	5	.25	-	80	0	

V = Volts A = Amperes C = C-Bias S.G. - Screen-Grid



CONSTRUCTION DETAILS of EARLY AERIAL TAP-SWITCH

MODEL "N"

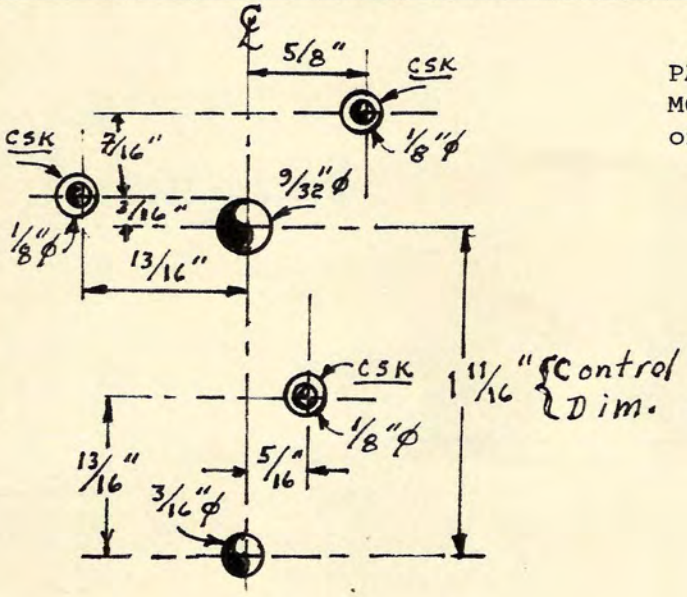
Capacity = 1.8/20 MFD

MODEL "G"

Capacities Varied with:
G1 = .00002/,0001 MFD
G2 = .0001/.0005 MFD
G3 = .0003/.001 MFD

Original Decalcomanias ("Decals") will frequently be found to have rubbed off or become obliterated over the years. If any part of an X-L decal remains, the above data may help you to identify what you have. This was a neat item, superior to most.

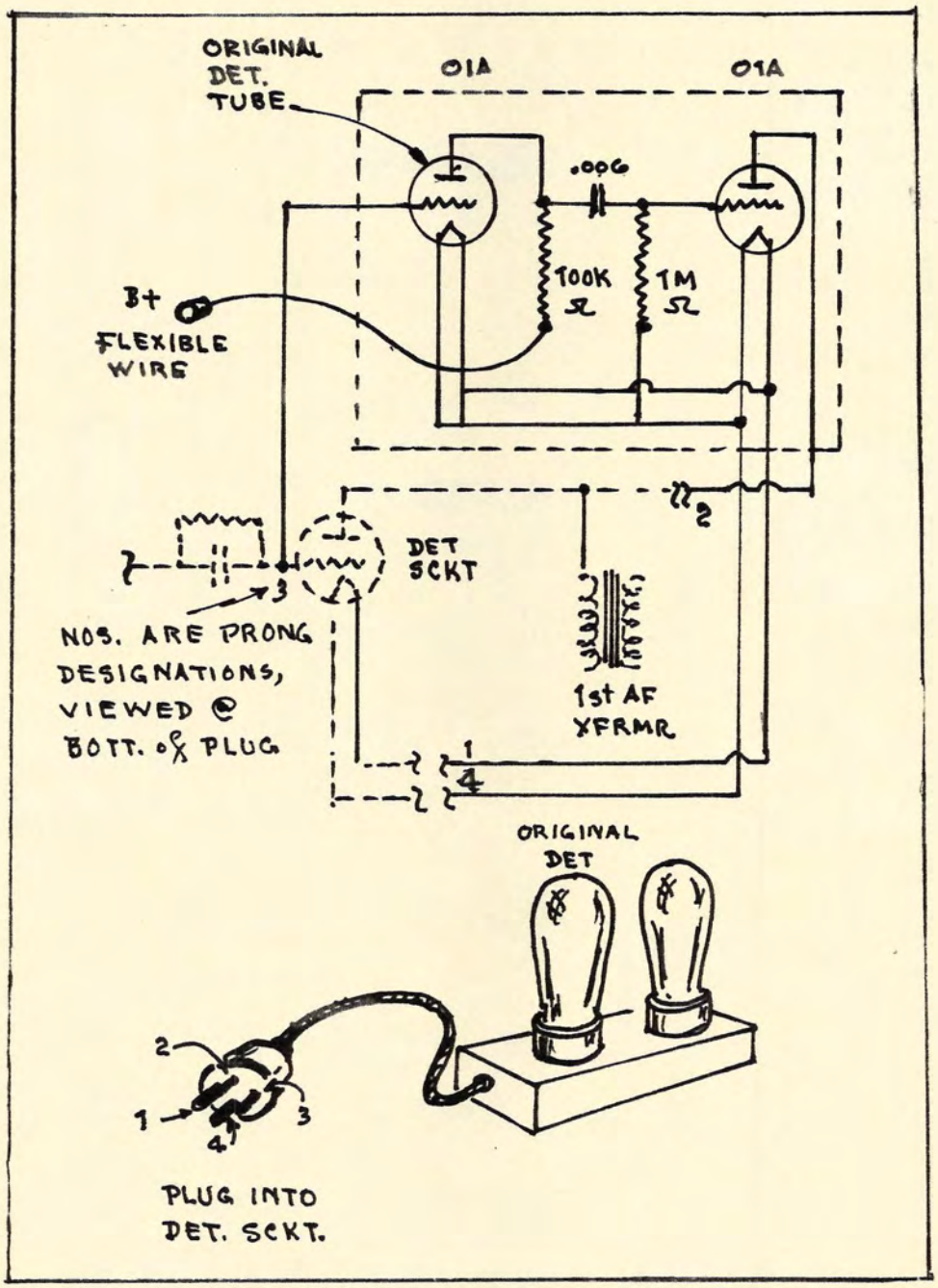
X - L IDENTIFICATION DATA



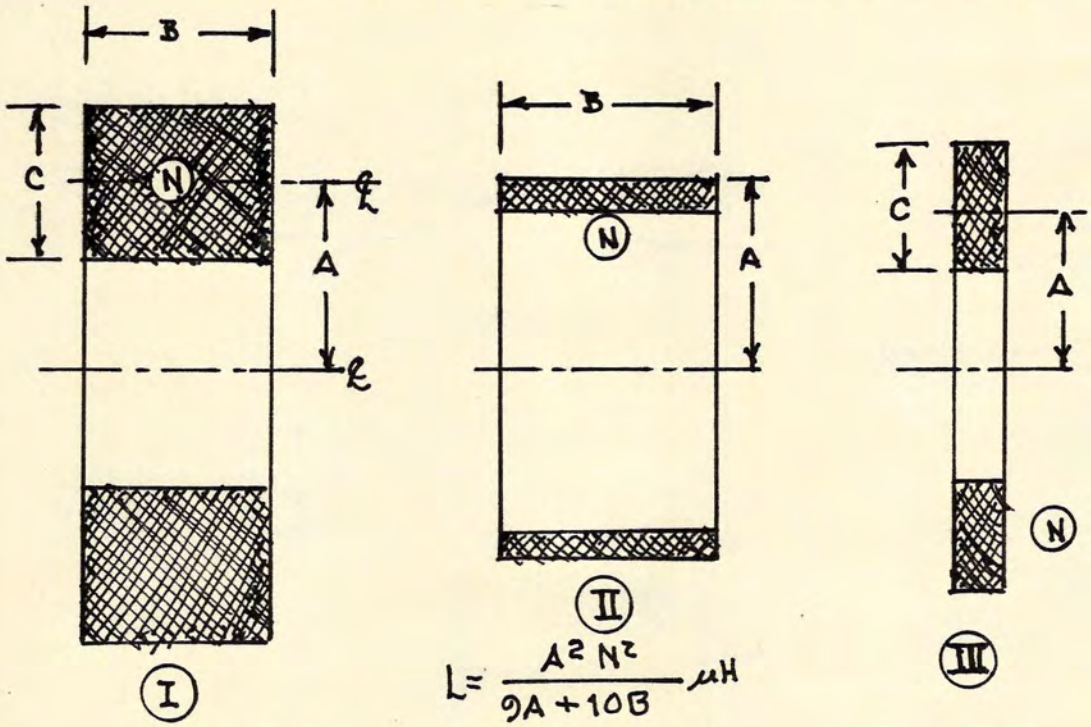
PANEL HOLE PATTERN FOR MOUNTING THE ACME "D"-COIL of 1925: See Vol. II-A.

(Full Scale)

A DETECTOR BOOSTER of 1928



EMPIRICAL CALCULATIONS FOR UNKNOWN INDUCTANCES



$$L = \frac{0.8A^2N^2}{6A+9B+10C}\ \mu H$$

SOLENOID

$$L = \frac{A^2N^2}{9A+10B}\ \mu H$$

SINGLE HELIX

$$L = \frac{A^2N^2}{8A+11C}\ \mu H$$

SPIDER-WEB

L	= Inductance	N	= Number of Turns
B	= Width of Coil	C	= Depth of Winding
mH	= Millihenries	A	= Center to Center

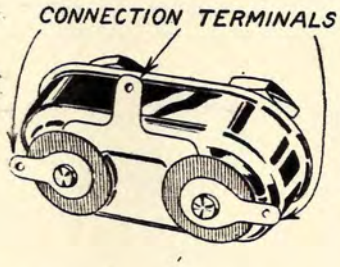
All dimensions must be in inches.

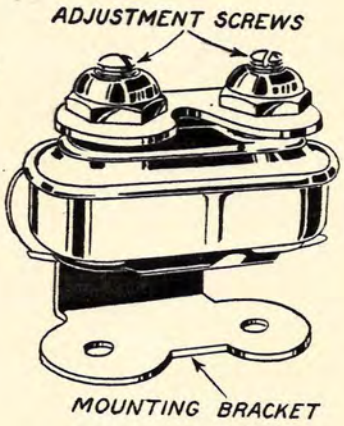
Accuracy is within 0.8% to 1% when the three denominators are approximately equal.

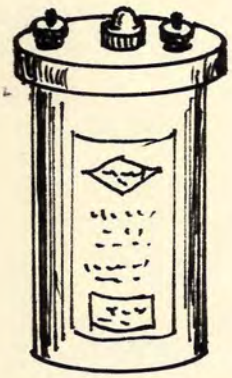
These formulae were developed by Harold A. Wheeler of the Hazeltine Labs in New Jersey during the Summer of 1928, and were presented at the I.R.E. meeting in October of that year.

MISCELLANEOUS IDENTIFICATION DATA

In 1926 the CLAROSTAT people introduced what they called a "Duplex Clarostat", the function & configuration being essentially as that shown. In 1937 they brought out a more sophisticated and larger version, shown at right. It was quite a useful device, and one that would be equally useful were it to be available today.





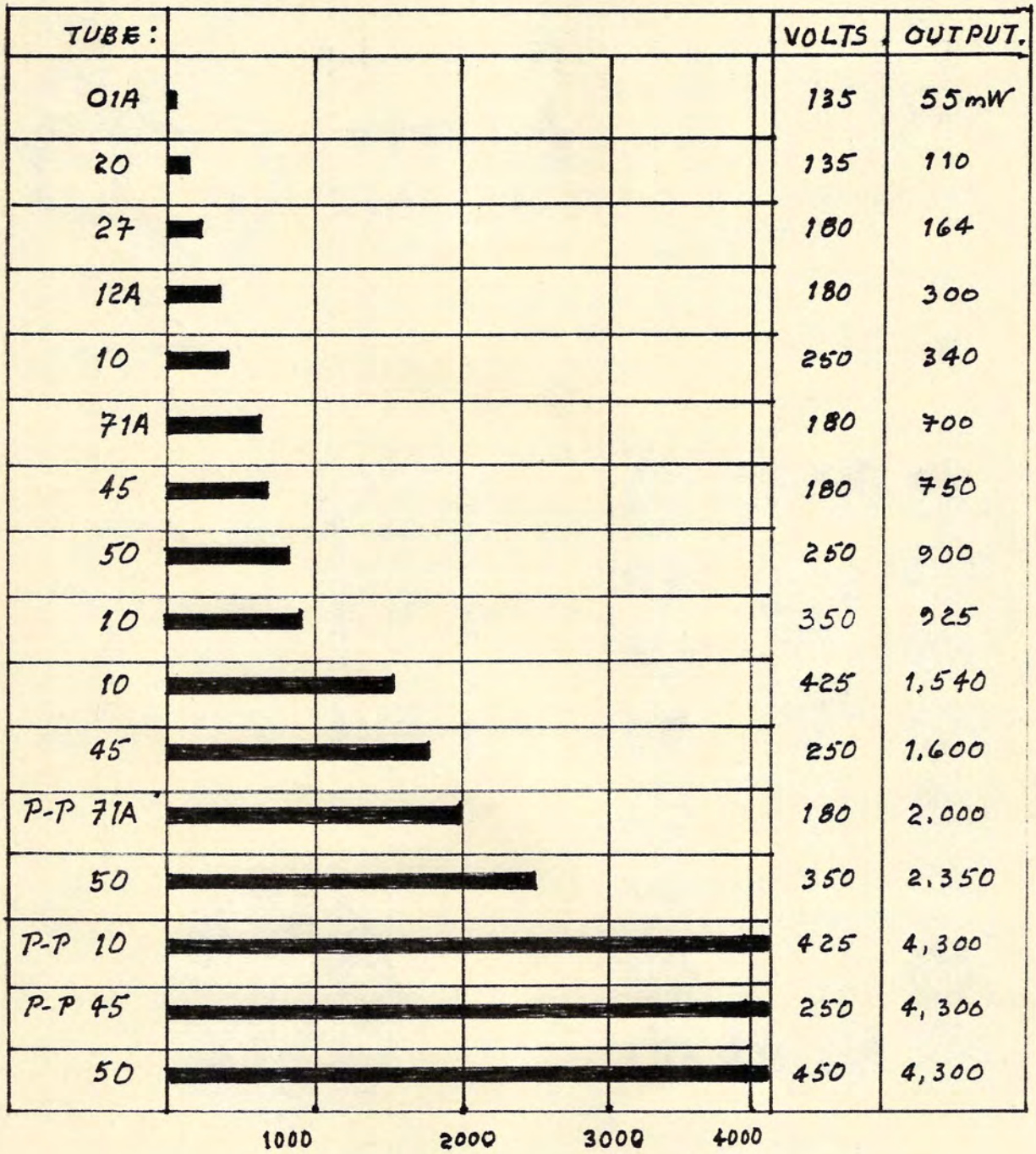


MAGNO STORAGE BATTERY - 1922

This unique battery was recharged by inserting spare electrodes; available then at 25¢ each.

ELECTRAD "VARIOHM" RHEOSTAT
1923

COMPARATIVE POWER TUBES OUTPUT



TUBE:	VOLTS	OUTPUT.
01A	135	55mW
20	135	110
27	180	164
12A	180	300
10	250	340
71A	180	700
45	180	750
50	250	900
10	350	925
10	425	1,540
45	250	1,600
P-P 71A	180	2,000
50	350	2,350
P-P 10	425	4,300
P-P 45	250	4,300
50	450	4,300

MILLIWATTS UNDISTORTED OUTPUT

(RC 1-30)

FILAMENT CONTROL CHART

TYPE OF VALVE	FILAMENT CURRENT IN AMPERES	BATTERY VOLTAGE	TYPE OF FILAMENT CONTROL NECESSARY
201-a	*.25*	*6*	*Amperite No. 1-A* *Polytrol No. 1* *Equalizer No. 4*
200-a	*.25*	*6*	*Amperite No. 1-A* *Polytrol No. 1* *Equalizer No. 4/3*
112	*.5*	*6*	*Amperite No. 112* *Polytrol No. 5* *Equalizer No. 2*
171	*.5*	*6*	*Amperite No. 112* *Polytrol No. 5* *Equalizer No. 2*
199	*.06*	*4 or 4.5*	*Amperite No. 4V-199* *Polytrol No. 2* *Equalizer No. 50*
120	*.125*	*4 or 4.5*	*Amperite No. 120* *Polytrol No. 6* *Equalizer No. 25*
WD-11	*.25*	*1.5*	*Amperite No. D-11* *Polytrol No. 4*
Any 1 Amp. 5 V. Valve	*1.0*	*6*	*Amperite No. 1* *Polytrol No. 3* *Equalizer No. 1*
Any .75 Amp. 5 V. Valve	*.75*	*6*	*Amperite No. 3-A* *Polytrol No. 7* *Equalizer No. 4/3*

The above data apply equally to other comparable tubes not listed, such as the 12A, 71A, Ce-Co A, etc. Radiart, Elkay, Lynch, Burnback were among the dominant manufacturers of such controls

The primary purpose was to provide the proper operating voltage for each tube. Where the control of filament current was also used as a volume control, such controls required conjunction with a suitable rheostat to prevent excessive current flowing in the filaments, even when the rheostat was at its OFF position.

Filament control devices, however, could not be used with dry-cell tubes, as the voltage variations would be too great to permit practical application of such controls. When more than one tube is controlled by a single unit, always turn it OFF.

Beyond Rider!

SEE BACK COVER

As ancillary adjuncts to this work by D.H.MOORE, refer to the listings over leaf for other works. For additional information and prices, send a self-addressed, stamped envelope to the publishers, or to either of the addresses below. An immediate reply will be forthcoming.

EAST OF THE MISSISSIPPI:

Olde Tyme Radio Company
2445 LYTTONSVILLE ROAD
SILVER SPRING, MARYLAND 20910

WEST OF THE MISSISSIPPI:

ANTIQUE ELECTRONIC SUPPLY
688 W. First St. • Tempe, AZ 85281 • U.S.A. • (602) 894-9503

OTHER PUBLICATIONS AVAILABLE

THE VINTAGE RADIO IDENTIFICATION SKETCH-BOOKS of D.H.MOORE:

Vol. I - *Introductory Essays*
" IIA - *Broadcast Receivers, A-L*
" IIB - *Broadcast Receivers, M-Z*
" III - *Short-Wave Receivers*
" IV - *Power Supplies & Amplifiers*
" V - *Hardware & Accessories*
" VI - *Early Test Equipment*
" VII - *General Technical Data*
" VIII - *The Early Years: 1910-1925*
Vol. IX - *Supplemental Data Sheets*

MONOGRAPHS ON SELECTED MARQUES:

PILOT	*VICTOREEN*	*ULTRADYNE*
SARGENT-RAYMENT	*REMLER/BEST*	*STROBODYNE*
BREMER-TULLY	*SCOTT (Early)*	*NATIONAL/HAMMARLUND*
BROWNING-DRAKE	*INFRADYNE*	*DOERLE*

Other MONOGRAPHS are in preparation and will be announced.

COPIES of ORIGINAL CONSTRUCTION BLUE-PRINTS:

ULTRADYNE L-2	VICTOREEN "Standard" & "Universal"	
"TROPODYNE"	BEST's 115 KC.	B-T "Counterphase Four"
SARGENT Pre-Selector & SW.Rcvr.		B-T "Counterphase Six"

A PICTORIAL DIGEST OF SELECTED VINTAGE RADIOS:

The Editorial Group, Ltd.

D. H. MOORE, A.D.I.
DIRECTOR

"Specialists In Technical Documentations"

P.O. BOX 521
PALO ALTO, CALIF.
94302